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IT seems that the law which was passed a year or more ago in New York, limiting the height of dwelling-houses to a maximum of eighty feet from the sidewalk, has, like so many others of the statutes which we pay our legislators for composing, proved a dead letter. It is not quite settled yet whether it was born dead, or died immediately after birth, but it is certain that it never showed any signs of life, and some doctors in the law assert that it never possessed the organs necessary to vitality. According to these learned men, the statute neither contained any provision for its own enforcement, nor mentioned any penalty for its violation; while, even if it had been fortified by these weapons, it was plainly unconstitutional, since it undertook to limit men in the enjoyment of their real estate, which, in legal theory, extends from the surface of the ground on which its boundaries are drawn to that heaven where titles and taxes have no place; and moreover, even if it had been originally constitutional and vigorous, it was repealed immediately after its passage, by the passage of the General Building Law of 1885, which contains precise provisions for the thickness of walls in dwelling-houses more than one hundred and fifteen feet high, under the rule that a subsequent statute abrogates and repeals all provisions inconsistent with it which may be contained in those previously existing. We have our doubts as to the unconstitutionality of laws restricting the height of buildings, but our readers will observe that a law which never had any life in it, nor possessed any vital parts, and which could not exist, if it had possessed them, in the pure, constitutional atmosphere of New York, and which, moreover, was killed immediately after it was born, need have no great terror for them, and, in practice, the people who wish to do so build houses a hundred feet high or more with just as much freedom as they did before the statute was passed. Fortunately for the people of New York, the lofty apartment-houses once so popular are coming into disfavor. Their great cost, as compared with that of humbler structures, made them doubtful investments in any but the most fashionable localities, and the infirmities of construction which some of those more carelessly or ignorantly designed have displayed, perhaps cast discredit on the rest, so that a twelve or fifteen-story flat in a second-rate situation in New York is just now not a very desirable piece of property to own, and it will be many years before the fever for building them comes on again.

VAN NOSTRAND'S ENGINEERING MAGAZINE adds a little to our knowledge of the properties of steel by means of three articles, two quoted from the *Engineer*, and the other from *Iron*. The first two are devoted to the consideration of the effect produced upon steel by working at black heat. According to these, a large part, at least, of the "unaccountable" failures of steel plates and bars, which, as it says, have caused many engineers to regard steel as "a treacherous material," are found to have been due to the bending or hammering of the metal while at a "blue", or "black" heat. "It should by this time be known," one of the articles continues, "that this is the most injurious treatment to which steel can possibly be subjected," and the effect of the same treatment on ordinary iron is somewhat injurious. To obtain some definite data on the subject, three hundred and thirty experiments were made, in which plates of moderately hard steel, of mild steel, of very mild steel, and of Lowmoor iron — the best and purest in commerce — were repeatedly bent, until they broke, some of the samples undergoing all their bending while cold, and the others being first bent once while at a black heat, and again after cooling. The pieces bent without heating did not differ very greatly in their flexibility, as shown by the number of bends that they would bear before breaking. Strangely enough, the mild steel samples were the least ductile, usually breaking, if bent without any heating, about at the thirteenth bending, while the very mild steel bore twenty-six bendings, the Lowmoor iron twenty, and the moderately hard steel twenty-one. If, however, any of the steel plates were heated to a point below redness, and then bent twice, they lost their ductility so completely that three-quarters of them broke with a single blow of a hammer, while three only, out of twelve samples, retained ductility enough to bear one or two subsequent bends. The Lowmoor iron, though injured by the bending while hot, was much less affected than the steel, and, after two bendings while hot, still retained ductility enough to be bent ten times more before it broke.

WHEN only one preliminary hot bend was given, the Lowmoor iron could be bent twelve times subsequently before breaking, while the very mild steel bore eleven bendings, the moderately hard steel three, and the mild steel two, or a fraction more; or, stated in another way, a single bending while hot deprived the iron of two-fifths of its ductility, the very mild steel of three-fifths, the mild steel of five-sixths, and the harder steel of six-sevenths. It must be remembered that these experiments were made with steel so lightly carbonated as to be naturally softer and more ductile than the purest commercial iron, so that, as the result of the experiment shows, all the steel plates bore bending while cold better than the iron, yet bending twice while hot, while it only diminished by one-half the ductility of the iron, rendered the steel samples so brittle that nearly all of them broke, almost like glass, at the blow of a hammer. The account says that it still is a common practice among boiler-makers to heat plates before hammering or bending, "to take the chill out," but that since scientific engineers have recognized and pointed out the danger of doing so, it is becoming the rule in some of the best shops to stop all hammering or bending of steel plates as soon as they have cooled down so far from a red heat that a piece of wood rubbed over them no longer leaves a glowing mark. This rough test seems to distinguish the condition of redness, in which either steel or iron can be wrought with safety, from the blue heat in which any hammering or bending is followed by the most serious consequences. Probably better tests than this will be devised before long, but in the meantime it is impossible not to suspect that there may be a connection between these results of what we are told is a common practice among boiler-makers and some singular failures of steel structures. We are not yet convinced that the loss of the *Oregon* may not have been partly due to some such condition of its plates, which served to increase in a moment a comparatively small injury into a fatal lesion; and the bursting of the Gravesend water-tower, which is as yet unexplained, may well prove to have been the result of some injudicious treatment of the steel plates of which it was built.

A FEW months ago there seemed to be nothing in the composition or structure of mild steel, as distinguished from iron, to account for this singular difference in their behavior under similar conditions of heating; but some examinations have recently been made at Creusot in France, by MM. Osmond and Werth, the results of which indicate that there is much more difference in texture between the two materials than has hitherto been suspected. Nearly all the treatises on the subject speak of wrought-iron as a fibrous mass of elongated crystals of more or less impure metal, generally adhering by their sides, but often separated by fibres of slag which had not been worked out in rolling or hammering; while cast steel, of the modern mild sort, is described as a homogeneous mass of nearly pure iron, containing a minute quantity of carbon in

solution. MM. Osmond and Werth, however, by placing very thin sheets of cast steel on a glass microscope slide, and covering them with nitric acid, found, as the metallic iron dissolved in the acid, that a cellular skeleton was left, composed of insoluble carbon, so distributed as to show beyond question that this sort of steel, instead of being a uniform solution of carbon in iron, is composed of an aggregation of cells of carbonate of iron, filled with soft iron, which contains no appreciable amount of carbon. By trying in this way different samples of steel, it was found that a similar cellular structure existed in all, but that in the metal from the ingot the cells were comparatively large, while remelted and wrought steel showed them small and much broken up. It would be difficult to connect at once this structure of mild steel with its behavior when worked while at a certain temperature, or when punched or sheared, but it seems by no means unlikely that there is a close relation between the two things, and it would be in every way desirable to have MM. Osmond and Werth's experiments, which are by no means difficult, repeated and extended wherever scientific metallurgy is studied.

M. EMILE TRÉLAT, the distinguished architect and writer on professional topics, sends to *Le Génie Civil* a most instructive essay on the lighting of rooms in dwelling-houses, with regard to the health of their inhabitants. It is unnecessary to say that, like all modern writers on the subject, M. Trélat regards light as an important factor in maintaining health, and thinks that rooms should be so constructed as to admit much more of it than is now usually the case. The physical effect of ample light is, as he says, to increase the action of the skin, and with it that of the lungs, while it nourishes and refreshes the nerves; and the effect of living in rooms insufficiently illuminated is to depress the spirits, to weaken the eyes and the lungs, and to render the skin pale and inactive. Physicians understand this well enough, and prescribe for their patients with depressed spirits and feeble nerves, regular and full exposure to the sunlight; but it is the habit of physicians to say little about matters beyond their control, and if they cannot get their patients out of doors, or into the sun-bath of a hospital, they content themselves with making the best of such windows as they find, without giving directions for altering them, or making over new the house in which the patient lives. With architects, however, who can direct the arrangement of new structures, the case is different, and they may with profit keep in mind the most favorable disposition of openings in this respect. In general, as most architects know, the brightest light comes from the zenith, and the amount of light which a window of a given size will admit into a room depends mainly upon the height above the horizon from which it receives its rays. According to Gwilt, an opening in the ceiling of a room admits ten times as much light as an opening of the same size in the centre of the side of the same room. M. Trélat does not give the proportion in the same way, but asserts that "the general rule for good lighting is to raise the head of the window to the greatest possible height." Especially is this necessary for rooms on courts or narrow streets, where nearly all the light which enters them must be obtained by reflection from the buildings on the opposite side of the street. As M. Trélat earnestly says, "the smallest ray from the zenith, if it succeeds in squeezing through the window into the room, pours into it a direct light a hundred times superior to the gray light reflected from the opposite wall," and it is surprising that although we all acknowledge in theory the truth of this, nine-tenths, probably, of the windows in our city dwelling-houses and office-buildings are set from one to two feet below the ceilings of the rooms which they are intended to illuminate, so that the direct light from the sky, which might easily have been admitted to all parts of the room, finds its way only, in the best cases, to a small area directly about the window-sill.

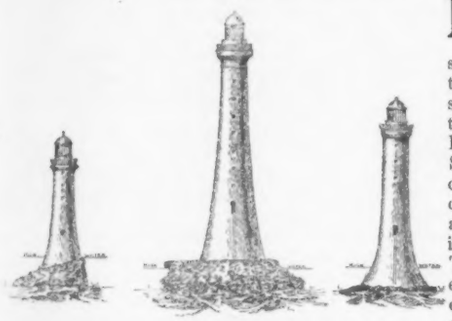
IF the window heads are carried within a few inches of the ceiling, as they should be, a sufficient amount of light, for rooms of the ordinary shape, is usually obtained by making the window-area one-fourth that of the wall in which the windows are placed. Perhaps a better rule, since it provides for rooms of all shapes, is that which requires that the window area shall be one-sixth that of the floor of the room, but for most cases the two rules would agree quite closely in their results. Having secured openings of the requisite size, properly placed, the architect, or the householder who wishes to have no nervous sufferers in his house must next see that the light which he has arranged to bring in is not shut out again by curtains or draperies. It is unnecessary to say that the ordinary upholsterer's pattern of window curtains cuts off about nine-tenths of the light which would otherwise willingly enter through the opening. The valance, or heading, which decorates the top of the draperies, has most to answer for, since it intercepts permanently the upper rays, but the lower portions, which are usually drawn back by a cord near the bottom, shut out nearly all but the horizontal rays; and even where circumstances prevent the use of drapery curtains, heavy painted or dyed shades are almost always kept drawn over the window, at least as far down as the meeting-rail of the sash, cutting off perhaps five-sixths of the light. M. Trélat, who complains bitterly of the "ruin" caused to the proper lighting of rooms by the ordinary disposition of curtains, which, as he says, is perfectly contrived for making rooms gloomy and dim, gives an illustration of window curtains sliding on a pole, like a portière, or the little silk curtains now often used over windows, which he regards as much better than the old-fashioned upholsterer's pattern; and with these, supplemented by semi-transparent shades, for shutting out too strong sunshine, a room may be so managed, as he says, that its inhabitants shall find themselves always within the salutary influences of the light, without being exposed to discomfort from rays of too great force.

L'ELECTRICIEN contains an extraordinary account of some experiments in hypnotism, in which a telephone was used, with the idea of seeing whether ideas could be communicated to a hypnotized subject through this instrument, without the aid of the personal influence of the operator. The hypnotism of the account is similar to what is known here as mesmerism, and the hypnotic state, like the mesmeric state, is brought on in susceptible persons by the mere effort of will of another person, but in other cases by directing the eyes steadily toward any bright object placed in front of them, and so far above them that it can only be seen by turning the eyes upward as far as possible. A few minutes of this exercise usually throws the patient into a condition of insensibility, in which, however, he perceives and obeys the will of one or more of the persons about him. The will of the operator can be communicated to the other either by words, or, in some cases, silently, and the intention of M. Liégeois and his friends was to see what would be the effect of interposing so material an object as a long wire between the two. With this idea a line about five hundred feet long was prepared, by making connection, through the central exchange, between a printing-office and one of the editorial rooms of a certain newspaper. A patient, or, as we should rather say, a victim, was then seated in the printing-office, with a telephone at each ear, and the proposition was made to him through the telephone that he should go into the mesmeric sleep. After two or three minutes of urging, he became insensible, still holding the telephone to his ears, and M. Liégeois then told him, through the telephone in the room, to stay just as he was until he waked him. He then walked over to the editorial office, and, taking up the telephone there, directed his patient, through the central exchange, to wake up, which he immediately did. The experiment was then repeated, and, instead of waking the patient at once, M. Liégeois ordered him, through the telephone from the editorial room, to go through various performances, such as sneezing, singing, imitating drunkenness or paralysis, and so on, all of which he did, with the obedient alacrity characteristic of a mesmerized subject. Many trials resulted in the same way, and, to judge from the account, either the telephone operators or the psychologists, or both, are likely to have some rather novel problems presented to them by those interested in following up the subject.

REPLIES to the circular which we sent to our subscribers on September 20, continue to reach us, so that we hesitate to begin the comparison and compilation of the vote for the list of "the twenty books an architect can least afford to do without." Still we can say that unless more opinions are expressed, the result will be far from conclusive, as at least ninety per cent of the books named must be classed as "scattering." If any one did not receive or has mislaid his circular we shall be pleased to send him a copy. The replies to the companion circular issued at the same time contain much interesting, and, to us, valuable information, and to this, too, we should like to receive a greater number of answers.

ANCIENT AND MODERN LIGHT-HOUSES.[1] — V.

BELL ROCK LIGHT-HOUSE.



BELL ROCK is a most dangerous sunken reef on the northern side of the entrance of the Firth of Forth, Scotland, and, consequently, a direct danger to all vessels entering the Firth of Tay. The nearest land, at Aberbrothok, is eleven miles distant.

It is uncertain how the rock came to bear its name, possibly on account of its shape, which somewhat resembles a large bell; but the tradition is that an abbot of Aberbrothok caused a bell to be erected on the rock which, by means of a floating apparatus, was rung by the motion of the waves, and that this bell was carried off by pirates. On this legend is founded the ballad of Sir Ralph the Rover, one of Southey's minor poems. It should be mentioned that in old charts this rock was called Inch Cape, or the Inch or Island of the Cape, referring to the Red Head, the highest and most remarkable on that coast.

Southey's ballad is as follows:

No stir in the air, no stir in the sea,
The ship was still as she could be;
Her sails from Heaven received no motion;
Her keel was steady in the ocean.

Without either sign or sound of their shock,
The waves flowed over the Inchcape Rock;
So little they rose, so little they fell,
They did not move the Inchcape Bell.

The Abbot of Aberbrothok
Had placed that Bell on the Inchcape Rock;
On a buoy in the storm it floated and swung,
And over the waves its warning rung.

When the rock was hid by the surge's swell,
The mariners heard the warning Bell;
And then they knew the perilous rock,
And blest the Abbot of Aberbrothok.

The Sun in heaven was shining gay;
All things were joyful on that day;
The sea-birds screamed as they wheeled round,
And there was joyaunce in their sound.

The buoy of the Inchcape Bell was seen,
A darker speck on the ocean green:
Sir Ralph the Rover walked his deck,
And he fixed his eye on the darker speck.

He felt the cheering power of spring;
It made him whistle, it made him sing:
His heart was mirthful to excess,
But the Rover's mirth was wickedness.

His eye was on the Inchcape float;
Quoth he, "My men, put out the boat,
And row me to the Inchcape Rock,
And I'll plague the Abbot of Aberbrothok."

The boat is lowered, the boatmen row,
And to the Inchcape rock they go;
Sir Ralph bent over from the boat,
And he cut the Bell from the Inchcape Float.

Down sunk the Bell with a gurgling sound;
The bubbles rose and burst around:
Quoth Sir Ralph, "The next who comes to the Rock
Won't bless the Abbot of Aberbrothok."

Sir Ralph the Rover sailed away;
He scoured the seas for many a day;
And now, grown rich with plundered store,
He steers his course for Scotland's shore.

So thick a haze o'erspreads the sky,
They cannot see the Sun on high;
The wind hath blown a gale all day;
At evening it hath died away.

On the deck the Rover takes his stand;
So dark it is they see no land.
Quoth Sir Ralph, "It will be lighter soon,
For there is the dawn of the rising Moon."

"Canst hear," said one, "the breakers roar?
For methinks we should be near the shore."
"Now where we are I cannot tell,
But I wish we could hear the Inchcape Bell."

They hear no sound; the swell is strong;
Though the wind hath fallen they drift along,
Till the vessel strikes with a quivering shock:
"O Christ! it is the Inchcape Rock!"

Sir Ralph the Rover tore his hair,
He curst himself in his despair:
The waves rush in on every side;
The ship is sinking beneath the tide.

But, even in his dying fear,
One dreadful sound could the Rover hear, —
A sound as if, with the Inchcape Bell,
The Devil below was ringing his knell.

At high water of spring tides the southwestern reef is about sixteen feet under the surface of the water, while that part of the rock on which the light-house is built is about twelve feet below. At low water of neap tides hardly any of the rock is visible, but at low water of spring tides the general level of the northeastern end, where the light-house is built, is about four feet above water, and occasional points are six feet above. Owing to the contrary tides the peculiar position of the rock and its dangerous character, ordinarily invisible, the need of a distinguishing mark upon it was early seen, and in 1793 Sir Alexander Cochrane made an official application to the Commissioners of the Northern Light-Houses, and they considered it an object of primary importance that one should be erected whenever funds should become available.

In the mean time public advertisements were inserted in the papers calling for some suitable plan. Several propositions were received. Notably Captain Joseph Brodie prepared a model of a cast-iron light-house supported on four pillars, strongly braced together. The design was not altogether approved by the Light-house Board, but the projectors had so much confidence in their plan that they erected, at different times, two temporary wooden beacons which, unfortunately, were immediately washed away.

The merchants of Leith, pleased by their perseverance, subscribed £150 toward the erection of a stronger temporary beacon, built of four strong spars, well braced and fastened with iron straps. The feet of the spars were let into the rock and also held to it by iron cemented to the rock with lead. This structure was erected with great difficulty in July, 1803. In the following December it entirely disappeared.

Mr. Robert Stevenson, the designer of the Bell Rock light-house, paid the first visit to the rock in August, 1803; as he was favored by both tide and weather he was enabled to land on the rock and remain there long enough to make a good sketch of it, during which time the boatmen devoted themselves to hunting for articles of shipwreck, and to such good purpose that before the tide overflowed they had collected a couple of hundred pounds of old metal of a miscellaneous character, among them being a kedge-anchor, a stove, a shoe-buckle, several pieces of money, a ship's marking-iron, etc.

These relics of disaster eloquently spoke the need of a light to mark this spot. The result of this visit was that Mr. Stevenson was convinced that the proper kind of tower to be erected here should be of stone in preference to the pillar form, as there was ample room for a large base, and besides, the tides rose so high that a vessel might come full sail against any erection made there — were the structure pillar-formed it might readily be damaged — but if the building were of solid stone it is not likely that the vessel would have any effect upon it.

The design was, therefore, made the same in principle as the Eddystone, and is shown on the plate. [See Illustrations.]

Various petitions were made to the Light-house Board, setting forth the danger of this rock and the great necessity there was of properly marking it, and though the Board recommended it, it was not until the year 1806 that the act of Parliament passed, authorizing its construction and appropriating a sufficient sum for its erection.

A clause had been introduced into the bill authorizing the collection of light-house duties of one penny half penny per register ton from British vessels, and three pence per ton from foreigners as soon as a ship or vessel was moored or anchored, and a floating or other light exhibited at or near Bell Rock.

In order that shipping might have the benefit of a light while the work was in progress, and also to have the benefit of the duties, a light-ship was fitted out; she was a Prussian fishing-vessel, captured by a British cruiser during the war of 1806, flat bottomed and rounded at both stem and stern; her capacity for rolling and incapacity for steering became proverbial, and later, when she was used as a storeship for the work, occasioned much trouble and uneasiness.

The first work on the rock was to clear it from sea-weed, and to trace the sites of the beacon-house and light-house on the rock; after this was done the first landing for erecting the beacon-house was made, which event was celebrated by three cheers and the regaling of each man with a glass of rum. Little work could be done the first day, but the holes for the holdfasts of the beacon were commenced, and the smith laid out a site for the forge.

The tide only allowed the men to remain two hours on the rock; when they returned on board they were variously employed in fishing, reading, drying their wet clothes, and listening to two or three companions who played the violin and German flute. They were blessed with reasonably good weather, and successfully bored all the dove-tailed holes for the iron holdfasts, and then commenced the cutting of the rock to receive the first course of masonry of the tower.

It was quite a problem as to the best method of landing the large stones for the light-house, and various plans were suggested, such as to attach a cork buoy to each stone and float it to the rock, or to use an air-tank as a float, to load the stones in light-draught, flat-bottomed vessels which could sail over the rock at high tide and drop the

[1] Continued from page 168, No. 563.

stones overboard; to build so much of the light-house ashore in a sort of coffer-dam as would raise the building to the level of the highest tide, and, having prepared the foundation to receive it, to tow the coffer-dam to its site and lower it to its place.

The method decided upon was to bring the vessels loaded with stone conveniently near the rock and to moor them, and then to transfer the stones to smaller deck boats, called praams, and to tow the latter to the rock at low tide, while the artificers were at work and ready to lay the stones in their proper positions. This method succeeded admirably; and when the first stone was landed all hands collected to welcome it and greet it with three cheers, and a glass of rum was served to each man. This formality accompanied every important step of the work. The next day after the first stone was landed, there occurred what might have been a most serious disaster. Soon after the workmen landed in the morning, the tender's boat and crew put off from the rock to examine the tender's moorings. The boat had no sooner reached the tender than the latter went adrift carrying the boat with her; as it was blowing hard it was with great difficulty that the crew could set the sails, and by the time this was done she had drifted some three miles to leeward, rendering it impossible for her to return to the rock until long after it would be overflowed.

The situation was indeed critical; there were thirty-two men on the rock, and only two boats which could carry in pleasant weather twenty-four men. For a long time the disaster was noticed only by Mr. Stevenson and the landing-master, as the men were busily employed at their respective tasks. When, however, the tide rose and the work of necessity stopped, the men went toward their respective boats, and to their astonishment found but two instead of three; no one uttered a word, the men looked at each other and at Mr. Stevenson; each man fully aware of the gravity of the occasion, and apparently calculating the chance of escape.

Mr. Stevenson had been considering various schemes by which to save the men, and attempted to address them; but his mouth was so parched that he could not utter a word; he stooped to get a little sea-water to moisten his throat, and as he rose he heard the cry of "a boat! a boat!" and on looking round saw through the haze a large boat coming toward the rock. This proved to be the pilot-boat from Abroath with letters; half the men were put on board of her, the other half took the two boats and after a hard row, for the wind had increased to a gale, arrived on board worn out and drenched to the skin.

The next morning but eight of the twenty-six workmen reported for duty, the rest had not got over their scare. When the eight returned from the rock, they saw the other eighteen on deck; but as the boat approached they went below; ashamed of their conduct. This was the only instance when the men refused to work, except the case of four Scotchmen, who would not work on Sundays.

After various untoward accidents, and a narrow escape from shipwreck of the whole party during a most violent storm the wooden temporary beacon was finally successfully erected; this was a most important proceeding, for the workmen could now safely remain at the rock all day; and the blacksmith could have his forge and bellows on a platform above the reach of the tide. When the beacon was finished, a small flag was displayed from its top "by which its perspective effect was greatly improved." The event was celebrated by three hearty cheers, and the custom of serving a dram of rum to each man was not forgotten. This closed the first season's work, and the workmen returned to Abroath. During the first season the actual working time was but thirteen-and-a-half days.

During the following winter the stones were cut to shape, and as may be seen by the plan, were dovetailed together; the outside shell was to be of granite to a height of thirty feet on the solid part of the structure; the rest of the building was of sandstone.

Various experiments were made as to the kind of mortar to be used, and it was found that a mixture of pozzolano and lime in a state of dry, impalpable powder, and clean sharp sand in equal proportions by measure, mixed with sea-water, formed a mortar equally good in all respects as when no sand was added.

Ordinarily it would have been difficult to obtain a sufficient number of good men to go on with the work, but as the men were exempt from the danger of being impressed on men-of-war, Great Britain being at war with France at the time, the work became very popular. The men were furnished with a ticket descriptive of their persons, to which was attached a silver medal having on one side a figure of Bell Rock Light-House, and on the other the word "medal." The Impress officers generally respected this.

On the 25th May, 1808, the workmen again embarked for the rock and landed; on the next day, the light-house colors were hoisted on the beacon.

The first course for the foundation of the light-house was finished at the stone-yard on the 4th June, the birthday of King George III. Work was carried on briskly at the rock, and by the 9th of June the foundation pit was completed and the first stone landed. At 11 A. M. the next day the stone, on which had been chiseled "1808," was securely placed, and Mr. Stevenson pronounced the following benediction: "May the Great Architect of the universe complete and bless this building," on which three hearty cheers were given, and success to the future operations drunk with the greatest enthusiasm.

By the 26th of July, the eighteen detached pieces of stone forming the foundation-course had been laid, and the whole surface brought to uniform level.

As the other courses when laid would be under water at high tide their weight was not alone relied upon to retain them in place, but they were also held by oaken treenails, as described in the construction of the Eddystone tower.

By the end of the season the base of the tower had been built to a level with the highest part of the foundation pit, or about five feet six inches above the lower end of the foundation stone. The men were at work during low water two hundred and sixty-five hours, only eighty of which were employed in building. During the storms of the following winter but slight accidents happened to the beacon, and these admitted of easy repair.

The first thing done the next season was to fit up the wooden beacon as a temporary residence. Work was commenced laying the stones, and by the 8th July the work was so far advanced that the high tide for the first time did not overflow the building, and the usual cheering and rum were indulged in.

On August 25 the last stone of the solid part of the building was laid, and the work on the tower closed for the season; this event also was observed with the usual ceremonies. The tower was now thirty-one feet six inches above the foundation course and seventeen feet above high water. In the next year the last stone was laid on July 30. During the year there had been various accidents and several narrow escapes, but fortunately no loss of life.

It is sufficient to show how high the waves would run up this tower, when it is stated that the men were occasionally driven from their work, even when the tower had reached the height of eighty feet. When the stonework had been completed, the tower was one hundred and two feet six inches high, and had reached the lintel of the door of the lantern. The lantern was built and glazed by the 25th of October. This closed the season's work.

Two light-keepers were left in the tower in October; the following November, when an additional supply of water and provisions were taken out to them, they were asked as to their experience. One of them stated that in storms when particular seas struck the light-house would tremble, and reminded him of the effect produced when a round log was hit sharply with a mallet, and though he had every confidence in the stability of the building, yet it "made a man look back upon his former life."

The lamps and reflecting apparatus were safely placed in the tower in December, 1810, and on the 17th of the month notice was given that on the night of February 1, 1811, the light would first be exhibited.

On the 30th July, 1814, Sir Walter Scott, Mr. Stevenson and several other gentlemen visited the light-house. They took breakfast in the library, and at the earnest entreaty of the party, Sir Walter, after inscribing his name in the album or visitor's book, wrote the following verse: —

Pharos loquitur. —
Far in the bosom of the deep,
O'er these wild shelves my watch I keep,
A ruddy gem of changeful light,
Bound on the dusky brow of Night,
The seaman bids my lustre hail,
And scorns to strike his timorous sail.

In conclusion, it may be of interest to state that this important structure contains 28,530 cubic feet of material, and weighs 2,076 tons.

THE TREATMENT OF SEWAGE.[1] — III.

I. — THE METHODS OF APPLYING THE SEWAGE TO LAND.

VARIOUS methods have been suggested, such as simple broad irrigation, as practised at Milan, converting the field into a water-meadow; and subterranean irrigation, pipes being laid sufficiently deep to be beyond reach of the plough. This may be called upward irrigation. Both of these plans have been tried and abandoned. Irrigation by hose and jet is no doubt that method of applying sewage which yields the best results (Smith of Deanstone, Chadwick, Mechi, Telfer, Kennedy). Professor Way says, "If you ask me how to make, regardless of cost, the manurial ingredients of the sewage into the greatest amount of produce of any kind, I would put it on with pipes and hose in small quantities almost as I would

[1] A paper by Dr. C. Meymott Tidy, read before the Society of Arts, April 14, 1886, and published in the *Journal* of the Society. Continued from No. 568, page 234.

in garden cultivation, as if I were watering it with watering-pots, but it would never pay you to do it." And, apart from this, you would never be able to get on the land the quantity that would meet the sanitary difficulty. This failing, sewage has to be brought to the highest points of the land to be irrigated, conveyed by carriers of a more or less permanent character into some form of sewer channels. The open carriers, or surface channels, may be mere trenches, or, if it be desirable that they should be placed above the ground, constructed of concrete or sheet iron, the sewage flowing in large or small volume, as required, upon the surface of the ground. Sometimes movable troughs are used (Carlisle), but usually the sewage is run through open carriers, and merely the land more or less flooded by the carriers being dammed up at certain parts. Simple contrivances only are required to turn on or turn off the sewage, as needed. The land must, of course, be so levelled and drained that the sewage may flow over different portions of ground, and not into hollows where it would become stagnant, or pass away without undergoing the needful purification.

II. — THE SOIL BEST SUITED FOR IRRIGATION AND FILTRATION.

We may distinguish three cases: —

1. Very porous soils. — A purely sandy soil has had its advocates, on the ground that it becomes richer every year that sewage is applied to it, irrigation thus serving to convert poor into productive land (Way). Bagshot-heath has found favor as sewage land with some, on the ground of its porous, sandy, and sterile character (Lawes; Paxton). In such soils, however, the effluent is generally very impure. A coarse, gravelly soil may be "free," but it most certainly, as a rule, discharges the sewage imperfectly purified, on account of its non-retentive nature.

2. Heavy clay soils, or rather, soils containing a notable proportion of clay, were approved by Liebig, on the ground that clay was the most effective soil for absorbing the valuable constituents of sewage, viz., the ammonia, phosphoric acid and potash. Liebig considered the success of the Craigentinny meadows to be dependent on the clay in the soil. It was his opinion that if the Maplin sands were to be used as irrigation land, 2,000,000 tons of clay would be needed to give them fertility to the depth of one inch.

A soil containing such a proportion of clay as to retard over-much the passage of the sewage through it, acts injuriously; in other words, it is over-retentive — the fact being that, to get the best effect of filtration, the filtration must not be too slow. The effluent is in such cases usually turbid and discolored.

A clay soil (*e. g.*, London clay, the stiff clay beds of the new red sandstone, and the boulder clay overlying the Oxford clay) is impervious to water. Such ground may be utilized by burning and mixing, although the cost of such treatment is considerable.

With clay, therefore, we may have either very slow filtration, the effluent being colored and turbid, or practically no filtration at all. Further, such soils are specially liable to crack and fissure, both by frost and extreme heat; in either case the sewage would run through the soil in an absolutely unpurified condition.

3. Soils intermediate between sand and clay. Perhaps a sandy loam or a loam with a small proportion of clay is that soil best fitted to yield a good effluent where irrigation or filtration through land is practised. Bailey Denton points out that the capacity of soils to absorb water (*e. g.*, a coarse, gravelly soil) is no criterion of its cleansing capability. On the contrary, he says, a loamy soil having sufficient sand to render it free and "to fill it with close interstitial spaces for aëration, will discharge a superior quality of purified water by the under drains." The best results I have myself seen are in the case of soils containing about 86 to 90 per cent of sand with a little clay.

The value of a plant-bearing soil as an absorbent, and possibly as an elaborator of plant food, is worth considering. Way supposed the absorbent action of a soil to be dependent on the chemical action of certain silicates of lime and alumina, which fixed the alkaline bases and allowed the acid constituents (phosphoric acid excepted) to pass in combination with lime. Liebig states that an acre of common clay soil, 4 inches deep, in the neighborhood of Munich, would absorb 2,076 lbs. of ammonia, 1,910 lbs. of potash, 888 lbs. of phosphoric acid, and that, like the stomach which fitted food for the wants of the animal, such a soil fitted sewage for the wants of the plants. Clay, in his experiments, was the best soil for irrigation, sand the worst, turf and peat being intermediate. Voelcker found that clay absorbed potash salts and ammonia freely from its solution, but never completely, the ammonia absorbed being, in great part, but not entirely, capable of removal by washing. Sand absorbed ammonia and potash salts imperfectly. Chalky and marly soils absorbed and rendered insoluble the soluble phosphoric acid more powerfully than either clay or sand.

Voelcker's experiments on the action of various soils on ammonia (*Journal of the Royal Agricultural Society*, xxviii, p. 544), show —

A. — As regards free ammonia: —

1. That all soils absorb ammonia from their solution, but that no soil absorbs it completely.

2. That the stronger the ammonia solution, the larger the absolute quantity of ammonia absorbed, whilst the weaker the ammonia solution, the larger the relative quantity of ammonia absorbed.

3. That if, after the saturation of a soil with a weak solution of ammonia, a strong solution be applied, the soil will absorb more ammonia from the strong solution.

B. — As regards salts of ammonia: —

1. That the soil absorbs the ammonia, the acid of the salt combining with the bases (lime, magnesia, etc.) present in the soil.

2. That absorption is greater with strong solutions of ammonia salts than with weak solutions.

The ammonia absorbed by the soil may be partly removed by washing with water, but the quantity capable of being thus removed is always relatively less than that retained by the soil — in other words, the absorptive power of the soil to absorb ammonia is relatively less than the solvent power of water to redissolve it.

These remarkable results are chiefly dependent on the alumina and hydrated oxide of iron in the soil, and in lesser degree on the presence of lime and other bases.

I wish to remark on the immense advantage in an irrigation-farm of ferruginous earth. I have seen a case where a very good effluent was obtained by the accidental circumstances of a small area (small, that is, in comparison to the entire farm) containing a large quantity of an iron deposit.

The composition of irrigated as compared with non-irrigated soils has been, on many occasions, contentious matter in the courts, and the subject of numerous investigations. The top few inches of an irrigation-farm present, no doubt, a very marked difference from the underlying soil, such difference being dependent partly on the nature of the soil, partly on the method of irrigation, but more particularly upon how far the suspended matters have been removed before the application of the sewage to land, and the extent to which intermittency of action has been practised. If, however, the top inch of the land be carefully scraped off, the difference of the composition of sewaged and non-sewaged ground will probably be found to be small. As regards nitrates, phosphates, and chlorides, the difference is, as a rule, absolutely *nil*. Perhaps there may be a slightly-increased amount of oxidizable organic matter, but even this is by no means invariable, whilst at a depth of eighteen inches, it is a very rare thing to find any marked alteration of composition. It is certain, therefore, that given land of ever so suitable a character as a sewage purifier, its powers are not those, agriculturally, of a storage battery.

Any excess of sewage over that which the plant can utilize at the time is, so far as commercial profit is concerned, wasted, passing off into the subsoil drainage partially or wholly unpurified. As a fact, the land does not store up any quantity of the manurial elements for the use of future crops. The fertility of a given area is not 10 times greater by the application of the sewage of 1,000 persons than it would be by the application of the sewage of 100. In fact, it is no better and no worse. The difference is to be sought in the effluent, not in the land. The Craigentinny meadows are still sandy and poor, despite of all the sewage put upon them. The land, notwithstanding all that has been done for it, still contains less than fifteen parts of organic matter in a thousand.

But how far is absorption dependent on the strength of the manurial fluid applied? Voelcker's investigations on this point have been referred to in detail. His experiments show that when manurial elements in a weak solution like sewage is applied to the soil, it merely oxidizes the nitrogen and strains the fluid, the resulting nitrates flowing away, unless vegetation is growing at the time, when the elements of the sewage may be appropriated. But more than this, his experiments show that a weak sewage may actually remove from a soil upon which there is no vegetation the manurial ingredients already present in it.

That the total soluble nitrogen of sewage may be found in the effluent as nitrates when the sewage is applied to land where there is no vegetation, or where vegetation is inactive, I have many times verified by analysis. (See Table, third report of commissioners appointed to inquire into the best mode of distributing the sewage of towns, 1865, page 46, showing, as the result of sixty-two analyses, that the drainage effluent water contained on an average the same amount of organic and inorganic constituents as the sewage.)

III. — CROPS MOST SUITABLE FOR IRRIGATION.

Nearly all agree that the most profitable application of sewage is to pasture land, osiers, and Italian rye grass. Way says that its application to grass land is the only profitable way of dealing with it — in other words, by feeding it into milk or flesh, and so getting a manageable manure.

Bailey Denton[1] holds a different view, considering that "the less the sewage farmer has to do with stock the better." He is of opinion that the cultivation of grass is unprofitable.

And here I may refer to the greediness with which cattle feed on sewage-irrigated pasture. Mechi states that cattle will follow the hose and feed on the grass wet with sewage. Many who gave evidence before the Parliamentary Committee on the sewage of towns testified to the same effect, the committee reporting that "the evidence proves that cattle of all sorts appear to prefer sewaged grass to all others, and will eat it within a few hours of its being dressed with sewage." And I beg your attention to this fact in passing, for I shall refer to it again when I speak of the dangers incident to eating the meat of animals fed on sewage produce.

I would note, too, that there is evidence to show that a damp and

[1] See Lecture on Maidstone Farmer's Club on "Sewage Irrigation as a Means of Disposal of Town Sewage."

sodden condition of ground, such as is common in a sewage-farm, is peculiarly favorable for the production of the "liver fluke" of sheep (*Diatoma hepaticum*), a disease occasioning great fatality. This danger of irrigation is not undeserving of attention.

Roots.—Some have advocated irrigation for root crops in dry weather (Campbell, of Rugby). The mangold-würzel does well in a sewage-farm.

Miller, of Edinburgh, is against the use of sewage for roots, since he found it made furrows and channels in arable land, and washed the roots of plants bare.

Bailey Denton advocates the growing of roots (mangolds, beets, turnips, carrots, parsnips, potatoes and onions) as better crops for sewage-land than the cultivation of grass.

Cereals.—Some consider sewage suitable for wheat. Mechi advocates its use, although not directly to the land so used (otherwise the wheat grows too luxuriantly and fills to easily), but to a preceding grass, root or clover crop.

The majority of authorities disapprove of its application to arable land, or of its use for cereals, roots, etc. Voelcker says, "It is quite unfit for cereals after the grassy state, because of its forming straw instead of grain, and checking the ripening process." Lawes, Way, Congreve (of Rugby), have expressed themselves to much the same effect. (See also evidence before Select Committee of the Sewage of Towns, 1862).

Its application to corn crops was tried at Watford, Rugby and Alnwick, but abandoned.

Bailey Denton advocates the production of straw upon a sewage-farm as advantageous for feeding stock, although the quantity of grain is small.

Voelcker condemns its use for market produce, "as it clogs the soil and kills the plant."

Bailey Denton specially advocates the cultivation of cabbages on sewage-farms. I remember being told that they had tried growing rhubarb at Aldershot, but that they abandoned it because nobody would eat it a second time, owing to its rank sewage flavor.

At the Brussels International Congress (1876), a collection of vegetables were shown, said to have been grown in fields irrigated by the sewage of Paris. There was a curious silence as to the cost of production.

Liebig, arguing on the quantities of ammonia and phosphoric acid in sewage, in comparison to the quantity of potash, considers sewage less adapted for grass crops than for pasture land. Say 4 tons of good hay (= 12 tons of grass) are grown on an acre of land per annum: this 4 tons abstracts from the land:—

Nitrogen	141.6 lbs.	(= ammonia 172 lbs.)
Phosphoric acid	72 "	
Potash	124 "	

To get 124 lbs. of potash you must have 2,400 tons of sewage. This contains:—

Nitrogen	451.07 lbs.	(= ammonia 547.73 lbs.)
Phosphoric acid	109.6 "	
Potash	124 "	

Now, in accordance with the law that "the effect of all the constituents of a manure is but the effect of that one of them which, in comparison with the wants of the plant, is present in the smallest quantity," it follows that 375.73 lbs. of ammonia, and 37.6 lbs. of phosphoric acid, are not merely wasted, but act injuriously by clogging the soil and killing the plants. On this ground he advocates adding to the sewage potash and phosphoric acid in proportion to the requirements of the crop, thus lessening the sewage required and increasing general fertility. Thus Liebig argues that sewage should always be used in conjunction with richer manures, guano being rich in phosphates and ammonia, but poor in potash; farm-yard manure being rich in potash, but poor in phosphates and ammonia; sewage occupying an intermediate position. The following table will serve to illustrate his views:

	Potash. lbs.	Phosphoric acid. lbs.	Ammonia. lbs.
193 tons of sewage yield	10	8.8	44.1
2,023 lbs. of farm-yard manure	10	9.0	14.9
1,672 lbs. of Peruvian guano	10	200.5	142.3

Voelcker scarcely endorses these views, for he says if the soil itself contain the elements of fertility, sewage has no more value than so much water; but if it be poor and barren, then the application of sewage will produce crops of grass when nothing else of any agricultural value will grow upon it.

IV.—Value of Crops Grown on Sewage-Irrigated Farms.

It must be admitted that the size and weight of roots and succulent vegetables grown on a sewage-farm are often considerable. Thus enormous cabbages, turnips, celery, etc., are often shown as sewage-grown. But sewage produce is best described as dropsical, *i. e.*, the percentage of moisture in sewage-grown produce is far higher than in the case of ordinary market produce. (This fact was proved by Lawes in his experiments at Rugby Farm). This being the case, sewage produce is difficult to dry and prone to decompose. It must be consumed fresh, and on the spot, for it will not stand being carried any distance to market. Dr. Voelcker is definite on this point. Irrigated land, it is certain, does not yield so nutritious a product as natural pastures. If you want good produce you must be content with small quantity.

Passing to the solid matter itself, a larger proportion of nitrogen was found in the sewaged than in the unsewaged produce, and the larger the quantity of sewage applied, the larger became the nitrogenous constituents of the vegetation.

PERCENTAGE COMPOSITION OF DRY SUBSTANCES.

	Plot I. No sewage plot.	Plot II. 3,000 tons sewage per acre.	Plot III. 6,000 tons sewage per acre.	Plot IV. 9,000 tons sewage per acre.
Nitrogenous substances	11.16	17.58	18.37	19.66
Fatty matter (ether extract)	3.41	4.13	3.95	4.04
Woody fibre	29.08	28.21	28.32	28.13
Other non-nitrogenous matters	46.73	39.09	38.08	36.91
Mineral matter (ash)	9.62	10.99	11.28	11.26

But here arises the important question, "Are nitrogenous constituents the true measure of the nutritive quality of a produce?" To this Voelcker replies "No." On the contrary, nutritive properties depend on proper maturation, whilst an excessive quantity of nitrogenous produce indicates unripeness, *i. e.*, a deficiency of sugar.

The Birmingham Sewage Inquiry Committee (1871) refer to the difficulty of disposing of the rye grass of the 140 acres of the Corporation Sewage-Farm at Saltley as an argument against the possibility of disposing of the produce of 4,800 acres it was at that time proposed to acquire. The difficulty of finding a market for the produce is the difficulty after you have encountered the preliminary difficulties of getting the produce. Ricks of rye grass and coarse hay are often to be found on the sewage-farm, untempting to the buyer, but serving to swell the balance-sheet of the farm by being entered as so much to the good.

Fattening power of sewage grass.—This question was made the subject of experimental investigation on ten Hereford oxen, two being supplied with unsewaged grass and eight with sewaged grass from land irrigated with 3,000, 6,000 and 9,000 tons of sewage per acre per annum. The reporters state the grass (sewaged or unsewaged) was not well adapted for the fattening of oxen without the addition of other food, such as oil cake. The two fed upon unsewaged grass increased 2½ lbs. per 1,000 lbs. live weight per week, and the eight fed on sewaged grass (of which a greater quantity was consumed per head per day than in the former case) increasing at the rate of 2¾ lbs. Such oxen, however, should yield, if fed on good fattening food, 9 lbs. to 10 lbs. increase per 1,000 lbs. per live weight per week.

Experiments with milch cows.—Experimenting on twelve cows, ten being fed on sewaged grass and two on unsewaged grass, the experiments clearly indicated that considerably less fresh unsewaged grass was required to produce one gallon of milk than fresh sewaged grass, and that a given weight of the animal was more productive when fed on unsewaged than on sewaged grass—but that a given weight of dry substance supplied in sewage grass was more productive than an equal weight supplied in unsewaged grass. The experiments with the rye grass, as regards milk production, are inconclusive.

The chemical analysis of the milk from cows fed on sewaged and unsewaged grass does not indicate any material difference.

But a case before the courts suggests that the milk of cows fed on sewaged grass is more apt to become sour than from cows fed on unsewaged grass. The cases are few, indeed, if there be any, where the keeping milch cows on a farm has really proved profitable.

I have thus far limited myself almost entirely to a consideration of the manurial value of sewage. We must now consider, in connection with manurial value, the second condition of effective sewage treatment, viz., the production of a good effluent.

There now arises the important question, how much sewage can properly (*quâ* agricultural success) and safely (*quâ* sanitary success) be applied to a given area of land.

There are two ways of applying sewage to land:—

1. Surface irrigation, or the distribution of sewage over as many acres as it will wet, having in view a maximum plant growth.
2. Intermittent downward filtration.

I.—Surface Irrigation.

And here one fact is certain, the agricultural and the sanitary aspects of the question are not in accord. To realize an agricultural success the farmer says, apply at proper times and seasons a large quantity of sewage (and within reason the larger the better) to your land. To realize a sanitary success, a sanitarian says, apply continuously as small a quantity as possible. If sewage be put upon a soil in larger volume than 1,500 tons per acre per annum, even when there is actively growing rye grass upon it, the subsoil water is certain to pass away foul (Way). It was found at the Anerley school farm that the same crop of grass was obtained when 1,500 tons of sewage per acre were applied by hose and jet, as when 8,000 to 9,000 tons were supplied by open carriers, but that in the latter case the effluent water was almost as foul as the sewage (Westwood). At Rugby it was recorded that with 3,000 tons of sewage per acre, a yield of 22 tons of grass was obtained, whilst with 6,000 tons of sewage a yield of 28 tons of grass, and with 9,000 tons of sewage a

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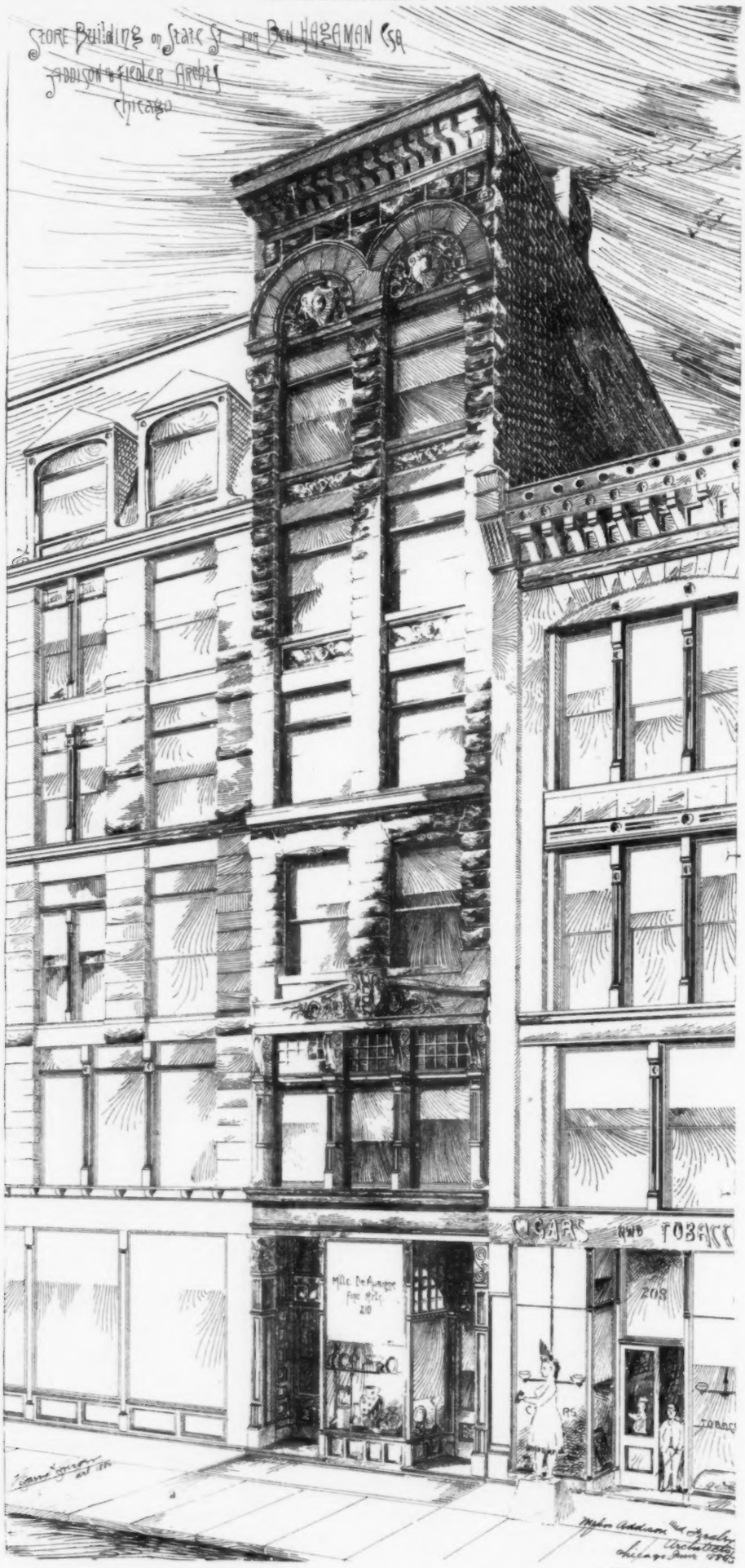

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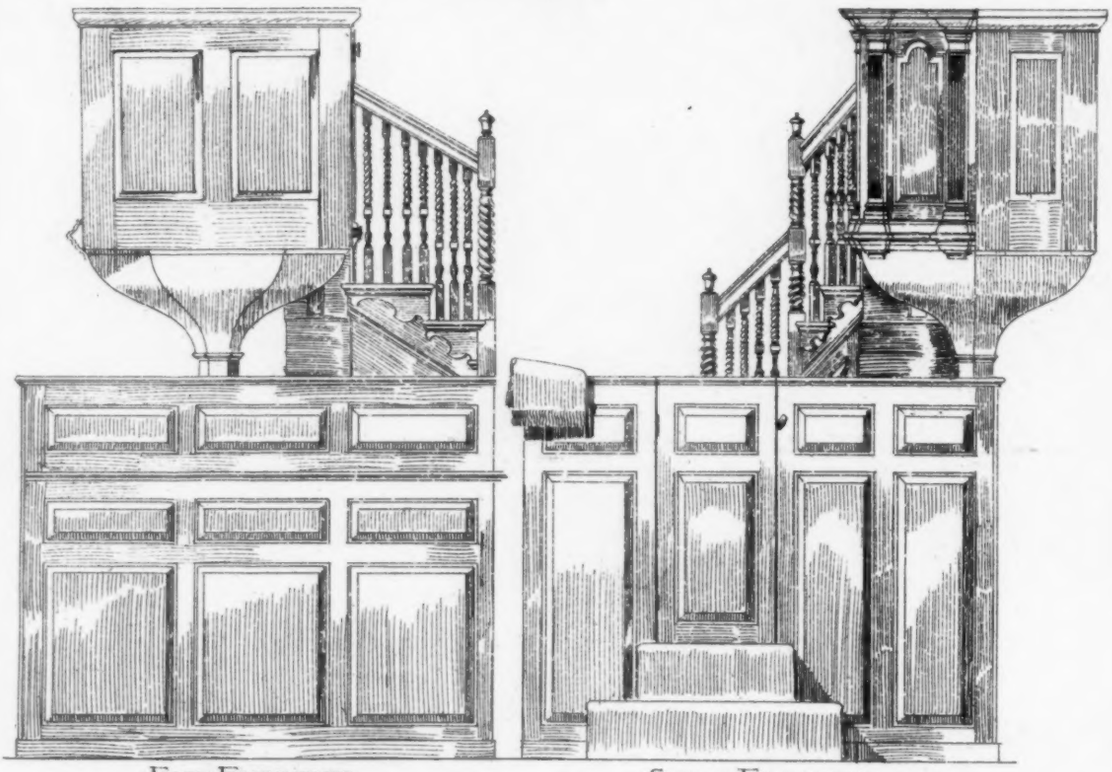
Kings Chapel., Boston Mass. I.

The Pulpit & Reading Desk

Scale

Measured and Drawn by Frank E. Wallis.



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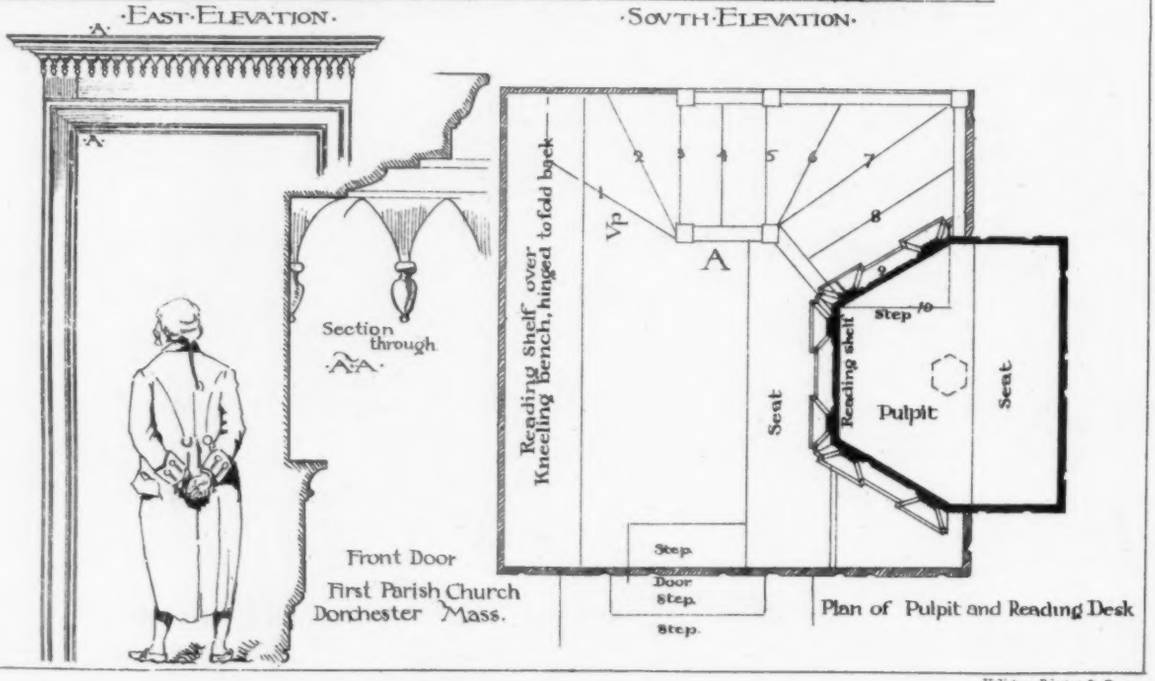

Plan of Pulpit and Reading Desk

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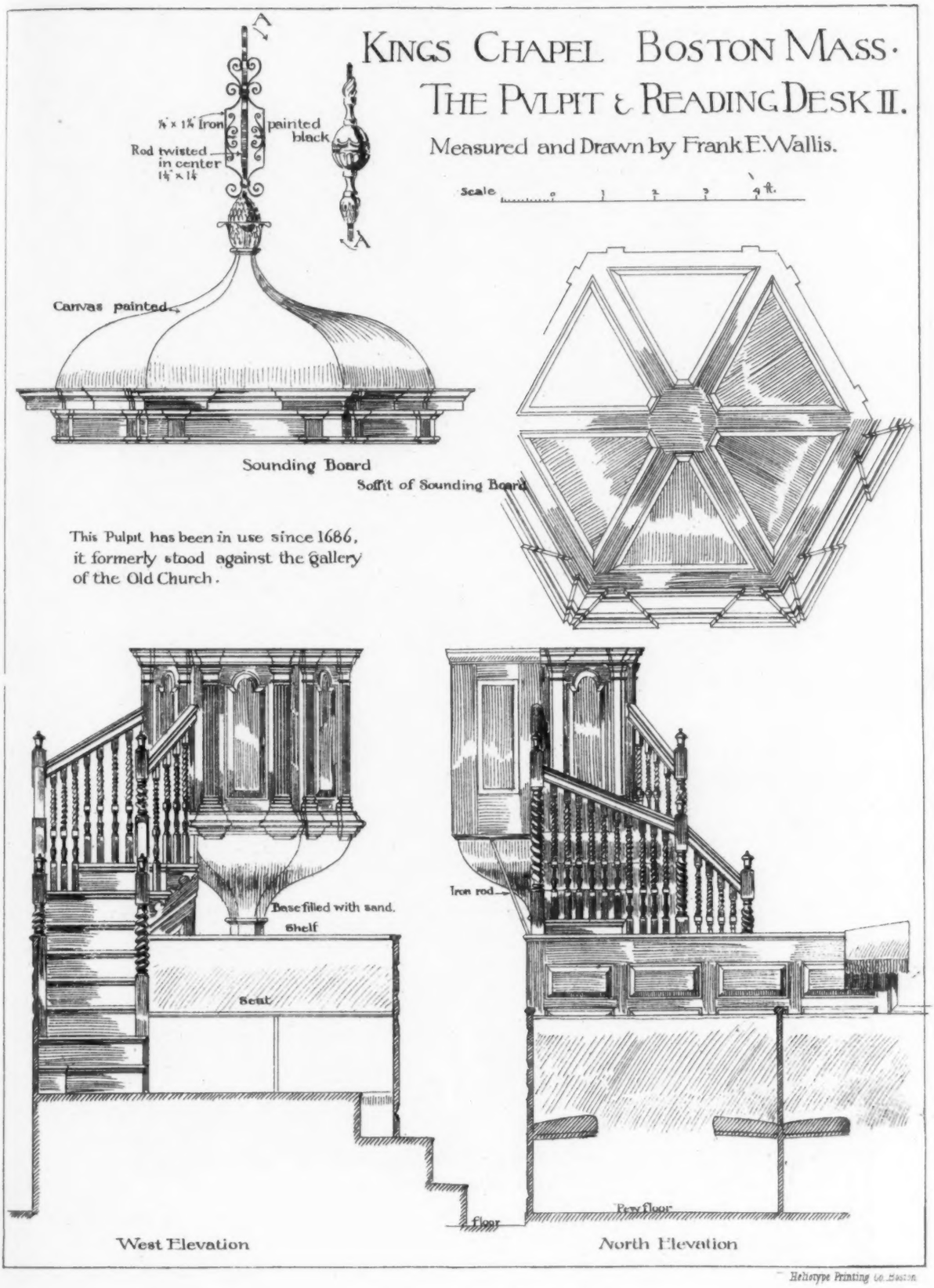

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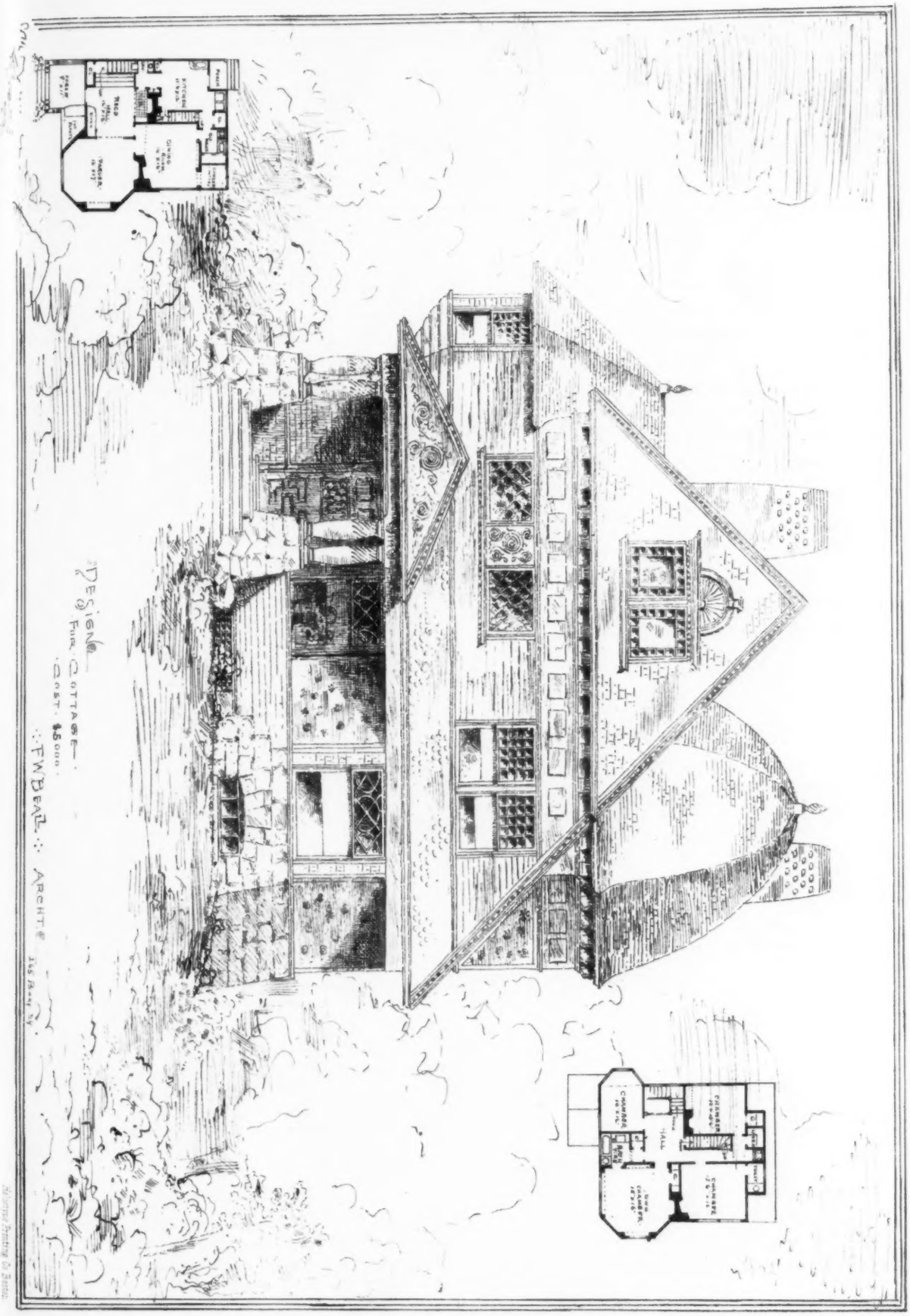


yield of 32 tons of grass only was obtained (Lawes). The conclusion is irresistible. There is a limit to the quantity of manurial elements that the soil and plants are capable of appropriating. Exceed this limit and any quantity in excess must pass away in a more or less unoxidized form.

As regards the quantity of sewage that is safe and proper to apply to land, I find authorities differ between 100 tons and 40,000 tons per acre per annum; a difference, in other words, between 2 and 800 persons per acre. Thus an authority "of great weight" expresses an opinion that 300 tons of sewage per acre per annum would accomplish as much as the 10,000 tons he had applied. Another authority considered the Rugby farm inferior to the Edinburgh meadows, because in the former from 3 to 9,000 tons of sewage per acre only was applied, whereas, in the latter, 10 to 12,000, and even 30 to 40,000 tons have been used. Mr. George Sheppard and Mr. Mechi considered 100 tons of sewage per acre per annum sufficient (or the manure of two persons). The latter lived to find his estimate erroneous, increasing his quantities at first to 500, and finally to 3,000 tons per acre for green crops. Miles, of Bristol, reported that two persons per acre gave good results, whilst Mr. Thomas Ellis considered (and in this Mr. Brady, the chairman of the Select Committee on Sewage, agreed), 600 tons of sewage (or the produce of a dozen people) advisable.

Mr. W. Hope and Mr. Westwood, of the school farm at Anerley, considered an acre of land was required for every twenty or thirty people (1,000 to 1,500 tons of sewage per annum), for, said Mr. Westwood, "if more than this be used, it runs away into the drains and fouls the stream." This he found to be the case when 8,000 or 9,000 tons per acre was applied to land cultivated with rye grass. Liebig considered 2,430 tons of sewage sufficient for meadow land to yield 12 tons of grass (4 tons of hay) per acre. He adds, a soil saturated with manure not only fails to increase the crop, but, in the case of roots, is positively hurtful. The Earl of Essex (Chairman of the Commission, to inquire into the best method of utilizing sewage), after many trials at Waterford, decided that 5,000 to 6,000 tons a year was desirable to each acre for Italian rye grass, but that 600 tons to each acre was sufficient in the case of meadow land. Voelcker fixes 2,000 to 4,000 tons per acre for better kinds of land, and 8,000 to 10,000 tons to sandy soils, stating "that he has nowhere seen such small quantities as 300 or 400 tons per acre produce any remunerative effect." Way likewise fixes 100 persons to the acre, provided the land be grass land, estimating that 30,000 acres of land would be required if the sewage of 3,000,000 people had to be dealt with.

Sir R. Rawlinson states the case thus:

"The means which have been found in practice to answer are as understated, namely, for flood irrigation about one statue acre to 100 of population of a fully water-closeted town, but there cannot be any hard-and-fast rule." (Suggestions, 1878.)

In nineteen irrigated towns, according to Professor Robinson ("*Sewage Disposal*," p. 79), there is an average of 137 persons to each acre (= to 5,128 gallons per acre per day, or 38 gallons of sewage per head of the population per day). Mr. McKie, of Carlisle, records the average of 53 towns as 98 persons to each acre (= to 3,826 gallons of sewage per acre per day).

Lawes and Rawlinson also agree that an acre of land is required for every 100 people (or 5,000 tons of sewage per year), a view agreed to in the main by Bailey Denton, who fixes 100 to 150 people, according to the porosity of the soil, lighter soil taking the sewage more freely than heavy. In Bailey Denton's opinion, however, extra land is needed for giving rest, and for permitting alternate cropping.

The difficulties, it will be seen, are tremendous. For commercial profit the sewage must not be less than 5,000 tons per acre — for sanitary efficiency (*i. e.*, to prevent nuisance), the quantity must not exceed 1,500 — *i. e.*, a minimum of 100 is necessary to pay — whilst 30 is the maximum to escape prosecution.

THE ILLUSTRATIONS

[Contributors are requested to send with their drawings full and adequate descriptions of the buildings, including a statement of cost.]

THE ROTCH TRAVELLING SCHOLARSHIP DRAWINGS. — PLATES XXX, XXXII, XXXIII.

[Issued only with the Imperial edition.]

HOUSE TO COST $5,000, DESIGNED BY MR. F. W. BEALL, NEW YORK, N. Y.

THE arrangement will be found compact, with opportunity for a very neat and artistic interior. First, a "reception-hall," with large fireplace under a 9′ arch, the floor of the recess tiled and a seat built in. A broad effect of staircase, with three windows following the rise, looking from hall to parlor, and from this to dining-room, which also connects with hall. You look from dining-room into small conservatory, which can be seen from main entrance of house. Butler's pantry connects dining-room indirectly with kitchen, with back staircase to second floor and cellar. There is also an indirect passage from kitchen to hall with lavatory under front stairs. Second floor: four bedrooms, principal chamber connecting with spacious bath-room containing good closet, also entering hall. All rooms, one excepted, have fireplace and ample closet or toilet. Attic to have billiard-room, servants' room and store-closets. Dumb-waiter running from cellar to second floor. Base of octagon to be of brown rock-face stone, laid up in red cement in irregular sizes; foundation to rear and sides to be of good quality brick. The two chimneys, where exposed, to be of good face-brick. House to be painted in subdued color; sienna, yellow ochre, chocolate, dark green, several tints of terra-cotta and indian-red trimmings. Hall to be neatly finished in oak (old); other rooms to be either white or yellow pine, painted in subdued colors, "dead finish," with frieze and wainscot of stipple work, with stencil pattern; to have neat picture-moulding and stair-rail. Each room to have neat wood mantel, tile trimmings. House to have furnace, running-water, gas, speaking-tubes, etc.

DETAILS OF KING'S CHAPEL, BOSTON, MASS. MEASURED AND DRAWN BY MR. F. E. WALLIS, BOSTON, MASS.

BELL ROCK LIGHT-HOUSE.

FOR description see article on "Ancient and Modern Light-houses" elsewhere in this issue.

STORE ON STATE STREET, CHICAGO, ILL., FOR B. HAGAMAN, ESQ. MESSRS. ADDISON & FIEDLER, ARCHITECTS, CHICAGO, ILL.

THE VENTILATION OF FACTORIES AND WORKSHOPS.[1]

OLD STAIRCASE IN COURT YARD
AFTER SKETCH BY HOKING. ROUEN, FRANCE.

THE efficient ventilation of factories and workshops is a very important branch of practical sanitation, and as I cannot find that it has been dealt with previously, I venture to put before you some considerations and suggestions which are the result of my experience in this particular line of sanitary work. As the chief trades carried on in factories are the textile trades, it may be interesting to know that, according to the census return of 1881, the number of persons engaged in those trades in England and Wales was over a million; of whom 530,000 were engaged in cotton trade, and 233,000 in the woollen and worsted manufacture; the remainder being engaged in the manufactory of hosiery, silk, lace, linen, carpets, hemp etc. In the cotton manufacture the proportion of the sexes employed was 164 females to every 100 males; in the woollen-cloth manufacture there were 102 females to 100 males; and in the worsted and stuff manufacture 180 females to 100 males; in the silk and ribbon manufacture the proportion of females was still greater, as there were 224 to 100 males. As there is no doubt that a considerable proportion of factory operatives are young persons, the importance of efficient ventilation is further emphasized, and is generally admitted by every one in theory. But, judging by the state of many factories and workshops, its importance is very slight, in practice; and the following extract from the last report of the Chief Inspector of Factories and Workshops is interesting in this connection. He says: "The injury inflicted by an unfenced piece of mechanism cannot be hidden, and inquiry as to its cause leads to a recommendation which prevent accidents in future. But the evils which follow constant employment in overcrowded and ill-ventilated workrooms, are insidious in their inception, rarely complained of openly by the sufferers, and do not in their effects appeal so readily to the sympathy of employers, as do the injuries to the person caused by machinery. It becomes thus a more difficult matter for us to deal with overcrowding and want of ventilation."

The particularly unhealthy conditions under which the textile trades are carried on, are commented upon as follows, in the supplement to the last annual report of the Registrar-general. He says: "Among the textile industries there are two in which the death-rates

[1] A paper by William Tattersall, read September 23, 1886, at the Congress of the Sanitary Institute, held at York.

are high, and unfortunately these are the two in which by far the largest number of persons are engaged — viz., the cotton industry of Lancashire, and the woollen and worsted industries of the West Riding. The comparative-mortality figures in these industries are 1,088 and 1,032 respectively. It can scarcely be doubted that the main cause of the differences is to be found in the conditions under which the industries are severally carried on, and especially in the differences that they present in regard to the dustiness and the temperature of their respective working-places. In the cotton factories the temperature of the weaving sheds is described in a recent (October, 1883) report, by Dr. Bridges, to the home secretary, as 'tropical and relaxing;' and dust, composed partly of filamentous particles of cotton and partly of mineral substances used for sizing, is stated to be a notable feature in most of the sheds." It will be found, also, on examining the tables, that the death-rates from diseases of the respiratory organs are very high in the Lancashire and West Riding towns, where the textile trades are mainly carried on. As the following extract from the supplement previously mentioned also indicates; writing of the effect of dust on the respiratory organs, he remarks: "More injurious than either coal-dust, wood-dust, or the dust of flour, appear to be the filaments and fluff and other dusts that are given off in textile factories; the mortality both from phthisis and from diseases of the respiratory organs being higher among workers in cotton and workers in wool than among persons exposed to either of the previously-mentioned kinds of dust. The workers in cotton factories fare worse than the workers in wool, the comparative mortality from the diseases in question being 543 for the former and 462 for the latter. It must be remembered, however, that the air in the weaving-sheds of cotton factories contains not only flocculent matter, but also a large amount of dust from mineral substances of various kinds used in sizing, and that the inhalation of mineral substances, judging from industries presently to be considered, is much more injurious than the inhalation of textile filaments. The deleterious effects of dust upon the air-passages is increased both in the cotton and in the wool factories, and especially in the former, by the high temperature in which the work is carried on, and it is impossible to say how much of the lung mortality is due to the latter cause, and how much to the dust.

So much then for the considerations as to the need of ventilation in factories, and I take it that if they had been more efficiently ventilated than appears to have been the case when the foregoing observations were made, and which, by my own observations, is the case now in most factories, the presence of polluting matters would not have been so evident, as they would have been got rid of as fast as produced, and so the evils resulting from their presence would have been much less.

I pass on now to the consideration of the means by which these evils can be lessened by an efficient system of ventilation, and in doing so I propose to consider the main sources of impurities separately, and in each case the production, amount, effect and removal of such pollution. The main sources of impurity in factories, I have found to be as follows: and I say nothing further of the impurity arising from or given off by the workpeople themselves, as that is seldom or never the only or main source, and is merged into the greater both in effect and removal. The principal impurities are dust, fumes, excess of moisture and heat. Objection may be taken to moisture and heat being considered as impurities, but in excess their effects are probably as ill as those of the actual impurities, and therefore they need removal.

In many cases several of these impurities are present together, aggravate the nuisance and often make its removal more difficult. Dust I have found to be the greatest impurity, and to be present, more or less, in almost all the processes through which textile fabrics pass in manufacture, and often where the stuff is made into clothing.

The rooms where the carding, combing, winding, spinning, etc., of cotton, woollen, worsted and other textiles is carried on, all have their air rendered impure by the dust and particles of fibre given off from the material in course of manufacture, and, in addition, the sheds in which cotton goods are woven, and especially with certain classes of goods, the solid particles of the size with which the yarn has been treated become loose, and in addition to particles of cotton, float about in the air of the shed in considerable quantities; and to prevent this result, and because more work can be got off in a certain time with a moist atmosphere, an apparatus known as a "humidifier" is used, by means of which saturated air at a high temperature is forced into the shed, keeping the air inside hot and moist, and to prevent radiation of heat and condensation of the moisture, all apertures that might admit fresh, cool air, are carefully stopped up, including both inlets and outlets for ordinary ventilation, if any have been provided, which in many cases they have not; some employers simply blow steam into the sheds during meal-times, and trust to that for keeping the place moist enough for their purpose during the rest of the day. An artificial moisture is most needed during frost; the effect of passing from the warm, moist air of the weaving-shed to the cold, frosty air outside, must be very injurious, as may be imagined.

A report on this subject was, I believe, made some years ago by Factory Inspector Osborn, in which he came to the conclusion, that by using proper ingredients in the preparation of size, there would be no need to introduce moisture into the sheds, and as the principal object of heavy sizing is, I presume, to give a fictitious weight and value to the cloth, not much sympathy would, I think, be extended to manufacturers if they were forced to discontinue such an unhealthy system.

In the weaving-sheds of other textile trades, as woollen, silk, worsted and flax, the impurities consist of dust and fine, loose particles of whatever material may be worked there; with, in winter, during a considerable part of the day, the impurities from a great number of gas-lights, and in summer, great heat from the sun shining upon the glass roofs, and in some cases always, and especially in hot weather, the foul smell from closets and urinals adjoining the sheds, and not properly ventilated or constructed, or not regularly emptied.

Carding-rooms, at particular times, when what is called grinding the cards is taking place, and the preparing-rooms for silk are extremely dusty. The breaking-up rooms also for other materials, such as waste, shoddy, and rags for paper makers, and esparto grass cleaning, and the rooms where these materials and wool are sorted into different grades or qualities, are often so full of dust that the workpeople, who are mostly women and girls, have to wear a bandage over the mouth and nostrils to enable them to work at all. In many of the workrooms enumerated above, there is a great excess of heat, and in some very foul smell arising from the material; the worst in this respect being probably silk-waste preparing-rooms, in some of which the stench is frightful to a stranger, though it is said that the workpeople become used to and do not perceive it after a while. In many workrooms also, other than textile, there is a large amount of floating dust to contend with, as in all dry-grinding processes where metal is ground on revolving discs, examples of which are: the glazing of metal faces in machine-shops on emery discs, and the pointing of pins for textile machinery, in which processes large quantities of minute particles of metal and stone are set free and float about in the air.

Excessive Heat.— There are many workrooms in which this is experienced. The machine-rooms in calico-printing works, some of which in summer get as high as 130° Fahrenheit. The machine-rooms also in paper mills, and the rooms in which fine yarns, both cotton, woollen and silk, are gassed, or run through flames produced from a mixture of coal-gas and air to finish them smooth. These rooms are the foulest that, in a considerable experience, I have come across, and this is not to be wondered at when we know that some thousands of gas-jets are burning, and the whole of the fine particles that have been singed off the thread, are floating about in the room, and produce an intolerably irritating effect on the throat, nose, and eyes of strangers; and I have often seen the women and girls forced to go outside and stay out a considerable time, to recover from the effects of working in such an atmosphere. The finishing, singeing, dyeing and pressing rooms for textiles have usually a very high temperature. The rooms in which wool is washed, and cotton and woollen yarns are sized and dried, and the drying-rooms for wool, yarn, cloth, etc., are among the worst, and especially as the excessive heat is accompanied with excess of moisture. I have known many rooms of this kind to have temperatures from 150° to 200° with the air so full of moisture that a fall of 20° would produce saturation.

The combing and spinning rooms are kept above normal temperature and artificially moistened, but it is said that it is necessary to produce good work.

In other than textile factories the ironing-rooms of steam-laundries, and the making-up and pressing rooms of wholesale clothing factories, in which much gas is burnt to heat the irons, are examples of workrooms in which the temperature is excessive, and the air foul.

Steam or excess of moisture, as an impurity, has already been mentioned several times, besides which it is found in excess mostly in dye-houses, where it is often produced in such immense volumes, and so continuously as to be quite beyond the power of any appliance to remove at a reasonable expense. In cold and foggy weather the moisture becomes most visible, as the point of saturation is sooner reached, and dye-houses become filled with thick fog for days together, so that nothing can be distinguished at a few feet distant. As dye-houses are generally of open and lofty construction, and there is no excessive heat, the health of the workmen does not appear to suffer much from their constant work among steam, and one hale old fellow of seventy-five, to whom I spoke, seemed to think it beneficial.

The construction of factories or rooms will govern the application of any system of ventilation to them. The ordinary method of ventilating weaving and other sheds has, I think, usually been inefficient by reason of the contrivances for exhausting the foul air being inadequate at their best, and uncertain in action when most needed, and also because the inlets for fresh air were not under control as to the quantity, temperature or direction of the air admitted.

The exhaust has usually been, by means of automatic ventilators of various kinds plentifully sprinkled about in the roof, and without, in many cases, any particular provision for inlets, or simply holes in the walls which allowed the air to enter in gusts, and insured their being speedily closed or stopped up with rags or anything else convenient. The lobster-back cowl, and other wind-driven ventilators, are liable to get stuck and act as inlets, and the same remark applies to other forms of ventilators which are driven by the wind, besides which in hot weather, when most needed, there would very likely be no wind to cause them to act. This last remark applies also to induced-current ventilators, besides which none of those mentioned produce, at the best of times, sufficient movement of air to carry away the particles of floating dust, so that, for this purpose, an

appliance is needed which will move air in large volumes constantly, and be under control, as to the quantity moved; this is found in a type of exhaust-fan, dealing with large volumes of air at low pressure, and requiring small power to drive, and which, placed near the centre of a shed, will exhaust air in proportion to the speed at which it is driven, and may be regulated to suit the temperature and other requirements, or amount of impurities existing. We thus get a current of fresh air traversing the shed from all sides to the centre, and there being *constantly* discharged, irrespective of wind or weather. In some large sheds, several may be necessary, and in one very large one I put four fans, having an aggregate displacement of 120,000 cubic feet of air per minute, or 7,200,000 cubic feet per hour, which changed the contents about eight times per hour.

The best results have been achieved by placing one or more exhaust ventilators near centre of shed roof, and arranging the inlets at regular distances around the walls. The amount of air to be passed through will depend on the temperature and rate of pollution inside, and the inlets may, if needed, be carried down from roof, and the entering air warmed, cooled, or moistened at pleasure; there are plenty of appliances to be had by which air can be admitted without draught. A series of rooms, one above the other, may, if not too large, be dealt with by one exhaust ventilator, placed at the top of a vertical shaft, extending through the several stories and with outlets from each room; the inlets for fresh air to each room being so arranged that the air may, in its course from inlet to outlet, traverse the room, and especially that part in which the greatest source of pollution exists.

It is obvious that a series of small rooms on the same floor-level may be dealt with in a similar way, by a horizontal air-duct with openings to each room, and inlets as suggested above. In storied rooms too large to be dealt with in this manner, each room may be treated separately, and many large workrooms are so treated, by having one or more exhaust-fans placed on one side of the room, and fixed either to discharge through windows or openings specially made. The inlets in this case would be arranged on the opposite side of room to fan, and possibly at the ends, if required, so as to cause the current of air to traverse the sources of pollution, whether dust, heat, fumes, or steam. Generally, the requisite effect in removal of polluting matters is obtained by running the fans entirely free from any kind of tubes or feed on room side; and, where possible, this is best, as less power is needed to drive them, and more air is moved when the area of feed is unrestricted. There are, however, some cases in which it is necessary, and many in which it is advisable, to carry away polluting matters immediately they are set free, so as to prevent their distribution in the atmosphere. In these cases it becomes necessary to construct tubes with openings near the source of pollution, and connected at the other, or exit end, with a fan, which, when working, produces a powerful exhaust, and carries away the polluting matter as fast as it is produced. This arrangement may be, and is, applied with perfect success to remove dust, heat, steam, and fumes of various kinds. The tubes may be carried overhead, underneath, or level with the sources of pollution, and the impurities carried away may be dealt with in a chamber, so as to retain them and allow the air to escape pure. A good type of this arrangement has been largely carried out for the prevention of what is called "wool-sorters' disease." The men who sort the wool work at continuous tables, which usually are fixed along the sides of large rooms, close to the walls, and at which each sorter works opposite a window, on account of the light. In sorting the wool, the sorter takes a portion from the heap placed on the table near him, and shakes it to loosen and open it out, so that he may judge of the quality, color, etc.; and it is at this point that the greatest danger of infection occurs, as the shaking sets free the dust, short fibres, and other light matters, amongst which may be the bacillus, or germ of infection. To prevent, or, at any rate, lessen the risk of infection, there is made, opposite each sorter, an opening in the table, to which is fixed a short, downcast tube, which is connected to a larger horizontal tube beneath the table, at the extremity of which is working a fan that produces a powerful exhaust current in the system of tubes, and carries away the dust produced by the sorters shaking the wool, which they do over the open ends of the small tubes.

In opening the bales of wool, also, a similar arrangement is used, but on a much larger scale, as the quantity to be dealt with is very much greater. In both cases there are wire gratings above the tables to keep the wool out of the tubes and allow the solid, but not floating matters to fall on the table for collection. This dust is most successfully dealt with by being blown into a settling chamber, in which a series of steam-jets meet and damp it, so that it is deposited, and can be collected and burnt periodically.

I may mention, amongst other applications of this system, the removal of dust from silk-dressing machinery, in which the main air-ducts are carried overhead, with small vertical dependent tubes, terminating in hoods, which cover the area of dust-production, confining it and facilitating its removal.

The fine dust produced by dry-grinding processes, in which metal is ground against rapidly-revolving discs of emery or stone, is also removed by a similar arrangement, in which the main tubes are about level with the grindstones, and have openings opposite each stone in such positions as to catch the dust as it is driven off and carry it away at once.

It will occur to any one acquainted with work in factories that this system of extraction along tubes may be applied with great advantage in many cases not specified in this paper. This is so; but, to avoid error, I have mentioned only such as I have designed and seen carried out, and are now in operation; and not all of these, by any means.

In the construction of the air-ducts, the following points need attention; and the suggestions I offer are the results of, and have been verified by experience.

The best material for tubes is galvanized sheet-iron of a gauge proportionate to the diameter of the tube; it is light and strong, and is easily made into tubes of a circular section, which are smooth inside, and reduce friction to a minimum.

Wood is the other material available for tubes, and the objections to its use are, that it cannot be formed into a circular section, is liable to warp, twist, and crack, and cause greater friction of the air, and consequent loss of power. Its advantage is that it is cheaper (about one-third) than galvanized-iron for tubes of same size.

In forming ducts inside walls or underground, the best materials are: for large air-ducts, glazed-bricks set in cement; or, for smaller ducts, glazed and socketed earthenware-pipes jointed in cement. Bends, and especially right-angled ones, should be avoided as much as possible; and, where unavoidable, should be curved to a large radius, or the tubes enlarged to reduce friction; inspection-holes should be provided near bends. Branch tubes should be connected to main tubes by being curved in the direction in which the current of air is travelling, and I have got the best results by bringing small tubes, such as those connected to the wool-sorters' tables, into the main tube at an angle of 45°, and enlarging them at the junction.

The openings near the fan should not be made too large, so that those farther away may get their due proportion of draught. If this is not done the fan draws its supply of air from the nearest openings, and the farther ones are of no use.

No particular rules can be laid down to work to in proportioning the sizes of openings according to their distance from the fan, as much depends on the sizes, materials, section, number of bends, and length of main tube; but a safe plan is to have each opening provided with a slide, so that they can be adjusted to give equal draughts, and then fixed to prevent tampering with by work-people, who very often imagine, if they see an open tube, that they feel a draught, and would rather, in many cases, stand the chance of infection than have the temperature of the room lowered by a good system of ventilation without heating. In one case I know the wool-sorters employed by a large firm petitioned that the system of ventilation described above might not be applied to their tables until the rooms had been heated by steam-pipes, which it took several months to do, and during which time they were working in a constant atmosphere of fine dust. In many other cases I have known work-people stuff up every opening, and even paste paper over every crack or crevice that might admit fresh air. This sensitiveness is no doubt largely due to the quiet, still nature of their work, which requires very little moving about or exercise, and causes them to feel the smallest movement of the air. At the same time there are many work-people who are very careless of the way in which they expose themselves or others to insanitary conditions, and will take their food without washing their hands, or removing their working smocks, and even take their meals seated on their work benches or table, and amongst the unhealthy matters they may have been manipulating, and this in spite of the fact that special facilities have been afforded them in the shape of washing and dining rooms. Though many of the operatives are no doubt very careless and ignorant as regards sanitation, still there are some who appreciate its benefits, and credit is due to those amongst the wool-sorters who agitated for compulsory by-laws to compel the best-known means to be taken for the prevention of the mysterious and fatal disease to which they are subject, which agitation resulted in a series of regulations being drawn up, and agreed to by the local authority, employers and operatives, which, though not compulsory, are generally carried out, and must contribute very greatly to the general health and comfort of the work-people

Employers are not always willing to take the necessary steps, and spend the necessary money to insure even moderately healthy conditions in their workrooms, where there is not a direct and perceptible result in better work turned out or more of it. This disinclination is to be traced in many cases to the fact that they have already spent considerable money in that direction without getting adequate results, and so become doubtful of any good result following further expenditure, though no doubt the feeling of some employers on the matter is similar to that of one who asked the cost of ventilating a room, in which the operatives complained of being nearly roasted, and on being told the cost, which was evidently much larger than he imagined it would be, he simply remarked, "Let 'em roast, then."

In conclusion, looking at the important bearing that the efficient ventilation of factories and workshops, not only in the cases mentioned, but also in very many others, has upon the public health, it seems to me that there should be some authority with power to compel the best known (or at any rate a satisfactory) means of ventilation to be carried out in what may be termed unhealthy trades. What that authority should be, or the circumstances under which it should act, I do not pretend to suggest, but think that the Council of the Sanitary Institute might profitably consider the matter, and prepare a recommendation on the subject.

The exhaust-ventilator mentioned in this paper is that known as the Blackman air-propeller.

THE CHATEAU DE CHANTILLY AND ITS TREASURES.

Gravestone of Thomas Clark, Mate of the "Mayflower," Plymouth, Mass.

It is somewhat surprising that although nearly a month has passed since the announcement of the Duc d'Aumale's testamentary disposition was made to the French public, so little has been said, so scant praise has been accorded in every mention published of this magnificent donation, whose real importance does not seem to be at all appreciated. The Orleanist newspapers called attention to the munificence of the giver, but in terms where a substratum of regret that it should thus go out of the family was apparent; the particular organ of the Comte de Paris scarcely noticed it at all, whence the conclusion that the Pretender was not pleased by this dereliction from the traditions of a family whose motto has always been "get all you can, and keep what you've gotten," while cynical Henri Rochefort sneeringly remarked that gratitude is inopportune, as in the first place, the motives of the gift were visible, to wit: a hope that the session of Chantilly to France might procure a rescission of the ukase of banishment; and in the second place, that as the entrance into possession of the legacy by the French Academy would be subsequent to the Duke's death, it would be better to wait and see if in the meanwhile he might not change his mind.

Republics are proverbially ungrateful, but in this case it has not been a question of republics; on all sides there has been a concert of that faint praise which, we all know, is as damning to man as the severest censure. Now, I am not an admirer of the Duc d'Aumale, whose military reputation is usurped, and whose literary reputation and seat among the Immortals of the Academy are due solely to the accident of his birth; but it is simple justice to the individual to say that the act by which Chantilly has been turned over to the said Immortals is irrevocable and cannot be rescinded; that it was not made with the view of having his banishment annulled; having been made and registered two years before that eventuality was foreseen. Whether it was made public in order to get up a feeling of sympathy in his favor is another question. But with this question I have naught to do; my intention is to tell what was given, not to speculate upon the motives of the donator, and when I reflect upon the difficulties of finding out the information which I now retail I can understand why it is that reporters have been so reticent as to merit the accusation of indifference. The people who have been left in charge of the château are singularly discreet, and there is scarcely anything left beneath its roof which can help the researches of an inquisitive visitor. The shelves of the library are empty, bare are the panels of the picture-gallery, and in the vestibule stand great packing-boxes stuffed with drawings and engravings, whose former places upon the walls are marked now with mere slips of papers. The Prince takes everything of value away with him, and as he intends to divide his future existence into two parts, so he divides into two parts his treasures; his books and his pictures go to London, his drawings and engravings to Brussels, which, if I were inclined to philosophizing, might furnish me with a text about the vanity of human affairs, and the painful strangeness of this contrast, when the owner is obliged to spoil his dwelling of collections precisely at the moment when he takes measures for their definite installation there after his demise.

The domain of Chantilly, ground and buildings inclusive, is estimated at 22,000,000 frs. to 25,000,000 frs., and as connoisseurs value the library and art treasures at 10,000,000 frs., as a minimum, 35,000,000 frs. may be taken as an approximative total, although, as will be seen as I go into details, these two estimates are much inferior to the reality, as among the collections are many objects which are inestimable. For instance, what money would be considered adequate compensation for the loss of the altar-piece by Jean Gorigon; of Mignard's portrait of Molière, the only authentic effigy of France's greatest writer, of the "Hours of Duke Jean de Berry," which is reckoned to be the most magnificent manuscript in the world, or of the correspondence of Richelieu? The annual revenue of the domain is about 600,000 frs.; but here again there is nothing definite, as the Institute will certainly turn to account much that the Duc d'Aumale has left unproductive, as, for instance, the pavilion of Enghien, a vast building with thirty-six windows of façade constructed by the last Prince of Conde for the accommodation of his guests and his suite; the famous stables as spacious as the castle itself; the château of St. Firmin, a delicious summer residence, standing in a park of nearly thirty acres, and the preserves plentifully stocked with game, which situated at only forty minutes' distance from the metropolis, will command any price among Parisian sportsmen. At present, Chantilly is burdened with charges of two kinds, an annuity of 200,000 frs. payable to the Crédit Foncier for the reimbursement of a loan of 4,000,000 frs., contracted by the Duke in 1874 for the reconstruction of the château. These payments will only end in the beginning of the next century; but a special clause in the act of donation permits the Institute to sell off some of the domain if it be deemed advisable to discharge the debt immediately. The other charges are a series of perpetual pensions, of which the total amounts to 30,000 frs., per annum. Admitting, however, that the Immortals do not take steps to increase the revenue, even when all yearly charges and expenses be paid, there will remain a clear sum of 300,000 frs. to be divided every twelve-month among the five sections of the Academy. The question has been asked, by whom will be discharged the transfer duty, which may be estimated at 350,000 frs.? By a special privilege granted to the Institute when it was reorganized it can receive all legacies and donations free of all duties and taxes. On that point, then, there is no difficulty to be encountered.

The domain of Chantilly was constituted seven hundred years ago. It belonged originally to the Counts Bouteillier de Senlis, then to the house of d'Orgemont, and by marriage, later, to the Montmorency, whose most illustrious representative the Constable Anne, of whom it was the favorite residence, has left there admirable traces of his taste for art. Anne lived at the most brilliant epoch of the Renaissance, and the greatest artists of the time, Jean Bullant, Jean Goujon, Bernard Palissey, and le Limousin, were at his service, which will explain why its present owner desired that the statue of the great Constable should have the place of honor at the entrance of a château, where every room recalls his memory. By another marriage, Chantilly passed into the possession of the Condé; it was part of the dowry of that Charlotte de Montmorency who wedded with Prince Henri II de Condé inspired so violent a passion in Henri Quatre, then a sexagenarian, that her husband thought the only safeguard to his honor was absence from the Court, and so eloped with his own wife to foreign parts. At the death — always attributed to crime — of the last Prince of Condé, in 1830, the Duc d'Aumale, his nephew, became heir to all the property, which, fearing confiscation, he turned over, by a fictitious sale, in 1852, to the English bankers, Coutts & Co., for the sum of 11,000,000 frs. In 1860 a map of the estate was engraved by M. Rhitoré, but this document is no longer exact, as, since his return in 1872, the Duke has made several important additions and a few small sales, which have materially altered its physiognomy. The most valuable portion of the domain is, as it always has been, its forests. North of the château there is the Parc du Grand Bois; south of it the Fôret du Chantilly, of Pontarmé, of the Lys, of Coye, and the Bois de l'Aigle, and of Royaumont, in all a superficies of over fifty square miles. These have been divided by the Duke into two parts, one of which is inalienable, another which the Institute may sell or keep as its members may elect. The first is considered by the Prince as a specimen of the management of woods and forests, which ought to be preserved like the monuments and collections forming the Condé Museum. Its limits are not yet definitely fixed, but they will in any case include within them the Grand Parc, the château with its dependencies, the forest of Chantilly, and probably that of Pontarmé. The total value of the inalienable part is estimated at 4,000,000 frs., and is about eight thousand acres in extent.

The ancient château of Chantilly was a feudal fortress, which, though altered and touched up by each of its successive owners, never entirely lost its harsh and massive aspect, and, having the appearance of a bastile, did not suit revolutionary ideas, so it was demolished by order of the Convention. But Constable Anne had had constructed close to the old building the little château or châtelet, which, though found great fault with by architectural purists, is an elegant edifice. The great Condé intrusted the laying out of the gardens and parterres to Le Nôtre, and although in the next century the latter were replaced by a *jardin anglais*, the splendid perspectives and the ornamental ponds and lawns were left untouched, and it is said, were so much admired by Louis XIV, that they were taken as models in the arrangement of the pleasure-grounds of Versailles. The stables, erected by a great-grandson of the great Condé, are among the finest specimens extant of French architecture at the commencement of the eighteenth century, and have often been mistaken, so monumental are they, for the château itself, by strangers who have begun their visit on the west side of the palace. Fortunately neither the châtelet nor the stables were destroyed by the agents of MM. Marat, Robespierre & Co. The property was restored to the Condés in 1815, and as Ecouen, which also belonged to them, had been given by Napoleon to the Legion of Honor — a school for the daughters of *legionaires* was established by him there and is still preserved — was left to the order, all the works of art originally there, which had been saved by Alexandre Lenoir, were transported to Chantilly, although not reclaimed by the last of the Condés, who was so little of a *dilettante* that, after his death the famous Psyche glass was found still in the packing-box where it had been put fifteen years before.

The Duke demanded of the Architect Duban in 1845 a "project" for the reconstruction of the château, but only in 1875 was its execution achieved by M. Daumet, who, in spite of the difficulties of

his task, succeeded admirably in the construction of a beautiful monument, in which there is a very harmonious continuation of the Renaissance style with certain details of the old feudal fortress, that ought to serve as an example to French architects, who for the last thirty years have covered the soil of Gaul with insipid, naked surfaces, baptized by them the Neo-Grec. The building was finished in 1883, but the ornamentation, intrusted to the sculptors Marqueste, Barthélemy, Wahnul and Maniglier, the painters Paul Baudry, Guiffart, and Le chevalier Chuignard, and the glass founder Bardou, is still incomplete. It has already cost 4,000,000 frs., and 600,000 frs. will scarcely be sufficient to pay the balance of the bill, and it was in order to insure the achievement of his undertaking that the Duke has retained the usufruct of the property, which the Institute was likely to let go to rack and ruin, as had happened for the châtelet, on which 1,000,000 francs has been expended, where such was the dilapidation that the Emperor Alexander, who was lodged there in 1815, always kept his umbrella open in the dining-room. The statuary in the garden has also cost a great deal of money. You see there the figure of the great Condé, surrounded by those of the artists and writers whom the victor of Rocroy had as his most familiar guests; La Bruyère, by Thomas; Le Nôtre and Molière, by Tony Noël; Bossuet, whose pedestal will be occupied whenever M. Guillaume shall have finished the statue. At the foot of the grand staircase are the mythological statues of Pluto and Proserpine, by Chapu, and in the court of honor the equestrian effigy of the Constable Anne de Montmorency, by Dubois, of which a copy reduced to three-fifths was exhibited at the last *Salon*. All of these are estimated to have cost at least 2,000,000 more, although the total value of the reconstruction and restoration is set down in the inventory of the domain at only 2,500,000 frs. By this example alone you can judge how much below the real figures have been all previous estimates. From positive documentary evidence it can be asserted that the true value exceeds 43,000,000 frs., 3,000,000 more than the sum restored to the d'Orleans family in virtue of the National Assembly's decree in 1872. — *C. T., in the New York Times.*

SOCIETIES

THE PHILADELPHIA CHAPTER, A. I. A.

AT the regular annual meeting of the Philadelphia Chapter, A. I. A., the following officers were elected:

President, Theophilus P. Chandler, Jr.; Vice-President, Edward Hazlehurst; Treasurer, John Stewardson; Secretary, Arthur Truscott; Executive Committee, Messrs. Charles Balderston, Walter Cope, James H. Windrim.

COMMUNICATIONS

MILL FLOORS.

BOSTON, MASS., October 29, 1886.

TO THE EDITORS OF THE AMERICAN ARCHITECT: —

Dear Sirs, — Having lately examined several of the buildings which are now in progress in Boston, in which the floors and roofs are constructed after the principles now recognized as "*the mill or factory floor,*" with heavy timbers wide apart, covered with thick plank, I observe one or two variations from the customary mill plan of which I beg to ask an explanation. There may be very good reasons for the principal variation but they are not apparent to me.

In the customary mill-floor the spans from wall to post, or from post to post crossway of the building, vary from twenty to twenty-five feet — seldom exceeding twenty-two feet; the beams are customarily placed either eight feet on centres, or ten feet four inches on centres, each set of beams resting directly upon the posts sustained by cast-iron caps, and not upon longitudinal girders. When the width on centres is eight feet, three-inch plank and one-inch top floor are customarily used for the floor proper: when the width is ten feet four inches, four-inch plank is used in place of three inch. These spacings have been adjusted to the conditions of setting textile machinery. Eleven feet on centres may be permitted with four-inch plank.

In some of the buildings which are being constructed for warehouse purposes, I find a different arrangement.

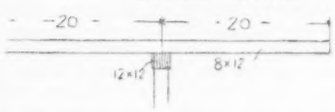
Assuming the building to be forty feet wide, the posts are set twelve feet apart; through the centre a heavy girder is placed upon these posts, and moderately-heavy floor-timbers are set about five feet apart on centres, from this girder to the wall. The objections to this course are as follows: *first*, the lesser number of posts; *second*, a heavy longitudinal girder exposed upon the top to dust, and in some measure interfering with light when the light is taken from either side of the building; *third*, a large additional amount of timber subject to combustion, and exposed at four corners; *fourth*, the placing of the floor timbers proper five feet apart is entirely inconsistent with the best adjustment of sprinklers, if the building is to be protected with any kind of sprinkling apparatus.

It is doubtless true that this disposition of the material may be theoretically a little stronger than the ordinary mill-floor, unless the sizes of the timbers used in ordinary mill construction should be slightly increased; and no exception may be taken to this plan where very heavy weights are to be put upon the floor, but for all ordinary purposes the mill construction would seem to be a better one.

In order that I may bring this point out with sufficient clearness, I have requested our Mr Woodbury to compute the strength of four different floors, on a factor of safety of six (6).

FLOORS. 40 × 100

Case 1.



Beams: 5 feet on centres.

Posts: 12 feet on centres.

Modulus of rupture for Southern pine divided by the factor of safety, $\frac{12960}{6} = 2160$

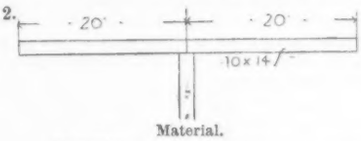
Material.	B. M.
2″ spruce flooring	8000
1″ hardwood "	4000
42 Southern pine beams 20′×8″×12″	6720
1 stringer beam 100′×12″×12″	1200
	19,920
8000 feet spruce.	20000 lbs.
10720 " hardwood	42880 "
4000)	62880
Weight of floor per square foot	15.72 lbs.

Strength per square foot:

$$W = \frac{Rbh^2}{9fsl^2} = \frac{12960 \times 8 \times 12 \times 12}{9 \times 6 \times 5 \times 20 \times 20} = 138.24 \text{ lbs.}$$

Deduct weight of floor	15.72
Safe load on floor per square foot	120.52

Case 2.



Beams: 10 feet on centres.

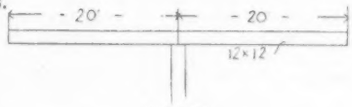
Material.	B. M.
3″ spruce	12000
1″ hardwood	4000
22 pieces Southern pine 20′×10″×14″	5134
	21,134
12000 feet spruce @ 2½	30000 lbs.
9134 " hardwood @ 4	36536 "
4000)	66536
Weight of floor per square foot	16.63 lbs.

Strength,

$$W = \frac{Rbh^2}{9fsl^2} = \frac{12960 \times 10 \times 14 \times 14}{9 \times 6 \times 10 \times 20 \times 20} = 117.69 \text{ lbs.}$$

Deduct weight of floor	16.63
Safe load per square foot of floor	101.06

Case 3.



Beams: 10 feet on centres.

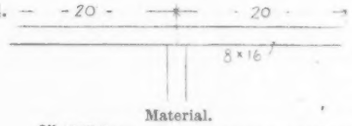
Material.	B. M.
3″ spruce	12000
1″ hardwood	4000
22 pieces Southern pine 12″×12″×20	5280
	21,280
12000 feet Spruce @ 2½	30000
9280 " hardwood @ 4	37120
4000)	67120
Weight of floor per square foot	16.78 lbs.

Strength per square foot:

$$W = \frac{Rbh^2}{9fsl^2} = \frac{12960 \times 12 \times 12 \times 12}{9 \times 6 \times 10 \times 20 \times 20} = 103.64 \text{ lbs.}$$

Deduct weight of floor	16.78
Net load for floor per square foot	86.86

Case 4.



Beams: 10 feet on centres.

Material.	B. M.
3″ spruce	12000
1″ hardwood	4000
22 pieces Southern pine 8″×16″×20′	4693
	20,693
12000 feet spruce @ 2½	30000 lbs.
8693 " hardwood @ 4	34772 "
4000)	64772
Weight of floor per square foot	16.19 lbs.

Strength per square foot:

$$W = \frac{Rbh^2}{9fsl^2} = \frac{12960 \times 8 \times 16 \times 16}{9 \times 6 \times 10 \times 20 \times 20} = 132.88 \text{ lbs.}$$

Deduct weight of floor	16.19
Safe load per square foot of floor	106.69

Number one is the plan to which I have objected, unless the weight proposed to be put upon this floor requires this disposition of the material to assure extra strength.

The other three correspond to the rules which would be adopted in the different floors of an ordinary cotton-mill, which are not subject to a heavier weight in any part of the mill, under ordinary conditions, than about sixty pounds to the square foot, averaging not over twenty-five or thirty including the weight of the operatives, but not including the weight of the floor itself.

Will some of your correspondents kindly submit a statement of the weights or loads on which they are accustomed to compute the strength of the required floors in buildings which are intended for ordinary commercial purposes and not for the extra weight which is required in the storage of tin in boxes, cheese and glass, which I believe are the three substances customarily requiring the heaviest construction. This mode of construction with the inner ends of the beams resting upon a longitudinal girder instead of being placed immediately upon the post and iron caps was given up in factory construction about thirty years ago, by all well-trained mill engineers and constructors, for the reasons which have been given, and also for other reasons.

In any mill of several stories, the shrinkage of the actual floor timbers is a matter of consideration with reference to the alignment of the shafting, but where the opportunity for shrinkage is doubled by resting a fourteen or sixteen inch timber upon a girder of the same kind, the difficulty in keeping shafting well adjusted is doubled.

Moreover, the effect of a heavy weight resting upon the side of a timber is very much greater and more injurious than when the weight rests upon the metal cap interposed between the floor timber and the head of the post. This bad effect more than offsets the slight additional weight which may be placed upon the floor constructed according to form number one.

So far as mill construction is concerned, the system of longitudinal girders has been absolutely condemned as unsuitable both from the engineering point of view, with a view to light, with a view to economy of material, and with a view to safety. For what reasons is it adopted in the construction of warehouses?

The proverb that the strength of the chain is measured by that of its weakest part is equally applicable to all forms of construction; as the good Deacon whose versified construction of a "One-horse Shay," vowed that

> "One thing is plain;
> The weakest part must stand the strain."

There is no error which is more common in the construction of buildings of a few years ago, involving wooden columns, than to see a wooden column supporting a wooden cap; or what is worse, directly against a wooden beam.

The examinations made for this Company on the strength of columns, on the testing-machine at Watertown Arsenal, showed that the resistance of Southern pine columns to compression averages about 4450 lbs. to the square inch; while the transverse resistance of Southern pine to crushing was about 1750 lbs. to the square inch, or about forty per cent. Therefore, a wooden column directly supporting wooden beams should have an iron cap at least two-and-a-half times the area of the cross section of the column, in order that the longitudinal resistance of the column and the lateral resistance of the beams should be required to resist intensity of pressure proportional to their strength in both instances.

Yours very truly, Edward Atkinson.

VENTILATING ROOF-SPACES.

Boston.

To the Editors of the American Architect:—

Dear Sirs,—I have under my charge a brick building 55′ deep, with composition roof pitching to rear. The question arises as to whether or not the space between roof and ceiling of upper story should be ventilated. I hold that if the space is opened at front and rear, the volume of heated air rising from the pavements will be drawn into it, while, if kept closed, the confined air would act as a non-conductor between the heated roof and ceiling. My position is questioned; will you be kind enough to decide which is the best practice? Very truly yours, H. Z. L.

[It is best to ventilate the air-space between roof and ceiling. The notion that the air, if confined, will act as a non-conductor, although common, is fallacious. On the contrary, the reverberation of heat between the roof and the upper surface of the ceiling raises the confined air to a very high temperature, which is communicated by convection and diffusion to the room beneath. If a good ventilation is kept up, the temperature of the air-space will never rise much above that of the air outside, and the room will receive little or no heat from the roof. — Eds. American Architect.]

A Large Glycerine Barometer. — The largest barometer in this country is that contrived by Zophar Mills at his office, 146 Front Street, New York. So far as Mr. Mills knows his is one of three glycerine barometers in the world. There is one in London and one in Scotland. Mr. Mills has had a glass tube drawn 31 feel long and with an outside diameter of 3½ inches. The inside measurement or bore is just an inch. It was hoisted to the roof of the Front-street building, and a hole large enough to admit the tube was bored through the roof and down through the several floors to the cellar. The tube was carefully lowered through this hole and suspended by a brass collar against the wall in Mr. Mills's office, which is on the second floor. The lower end of the tube hangs in a cistern filled with glycerine in the floor of the cellar. The advantages of Mr. Mills's big barometer are these. It is so big that slight variations can be read at sight and can be seen from a distance and at a glance; the variation in movement is not only great, but it is quick, and Mr. Mills thinks his big barometer will give a hint of coming storms two or three hours before a mercurial barometer will show a depression. — *Springfield Republican.*

TRADE SURVEYS

A simple statement of transactions in iron, steel, lumber, coal, cotton, wool, petroleum, and in some other of the leading staple productions of the country for the past week would in themselves be a sufficiently full presentation of the existing industrial conditions. To put the case in a nut-shell, an enormous amount of business has been transacted; prices in nearly all these products are slightly higher than they were a week ago. By way of prediction, it may be said that the probabilities to-day point to a slightly higher range during the next two or three weeks. The reasons for this statement are these: that the fullest production in our industries are promptly absorbed, that orders are increasing in number and magnitude, that new schemes calling for supplies of all kinds are constantly coming to the surface, and that there are increasing assurances every day that the present productive capacity is not in danger of overcrowding the markets. There are a multitude of other minor points which are entitled to some attention; only two or three of them will be referred to. One of them is, and perhaps the most important to the building interests, that a large amount of real estate has changed hands during the past month in the interest of projectors who contemplate erection of dwellings. Advices from several Western cities and some towns show that this policy of purchasing land for building purposes is quite general, and a great deal of land continues to be bought up in the vicinity of New York and Brooklyn. The same is true at Philadelphia. No less than a dozen schemes have recently gone through, and preparations are being made by the projectors for the erection of houses next season to cost from two to three thousand each. The same activity is observable in Chicago and in some other Western cities. This activity in lots for building purposes means a good deal more than appears on the surface. It points to the fact that property is advancing, that the industries are upon a very safe footing, and that manufacturers and builders have confidence in the existing trade foundations. Another point deserving of attention is the fact, and a by no means insignificant one, that railroad builders have finally determined upon the building of an immense amount of mileage next season. The word immense is used advisably. A summary of the enterprises announced in railway journals and in our leading dailies, justifies the statement to all appearances, and railway building is at hand. All of the trunk lines are engaged in schemes of extension of mileage. Nearly all of the Western roads have schemes on hand looking to the building of new roads, long and short. During the past week nearly 100,000 tons of steel rails were contracted for. For ordinary lots prices have advanced 50 cents, but for the danger of importation prices would advance $2 per ton. Even as it is, contracts were placed last week for 40,000 tons to be delivered at New Orleans.

The smaller industries also present encouraging features, and woodworking machinery interests are crowded with orders, and car-builders have lately been obliged to ask a delay upon business presented to them. The bridge-builders have contracts for between three and four months' output. The Western manufacturers of agricultural implements have felt the improvement to such an extent that for two or three weeks past they have been crowding in material, and, in consequence, merchant-steel has advanced five to ten per cent in the West. Reference has been made heretofore to the improvement of money-lending facilities between the East and West. During the past few months several large financial institutions have completed arrangements by which loans can be made in small or large sums to Western borrowers. This tendency has been stimulated by the difficulty of finding profitable employment for money in the East, and by the low rates ruling here. It is reasonable to predict that more attention will hereafter be given to the financial needs of the people in the West and South. Notwithstanding the outflow of the West, financial reports show a steady inflow from the business-distributing centres of the West to Eastern financial centres. The building statistics for the past week of both East and West show that activity has fallen off very little. Architects are already consulted upon building schemes for the coming year in some of the Western States. The indications point to some very heavy operations in manufacturing directions. Companies have been incorporated to push manufacturing upon large scale in the States between Ohio and Wisconsin. The leading industries have not been in so vigorous a condition as at present. Margins are gradually widening, confidence is increasing in the permanency of markets. The coal trade has recovered from a slight despondency, and producing companies both East and West are now crowded with orders which cannot be filled promptly on account of the scarcity of cars. Lumbermen and iron-makers indulge in the same complaint as to the scarcity of rolling-stock. The lumber-trade is very active in all markets, and, notwithstanding the heavy arrivals from both the West and South, stocks in Atlantic ports are rather light. Stronger lumber quotations are probable. That which most interests builders and architects at present is the probable course of prices of materials for the coming season. The highest authorities in the New England States adhere to previously expressed opinions that there will be very little, if any, advance, and give, as a reason, that the legitimate reasons for strengthening prices is about exhausted, and that with our enormous producing capacity any speculative advance is out of the question. The builders and manufacturing interests in the Middle States are extremely busy, but much of the business now placed is for winter and spring delivery, especially in the iron and steel industries. The belief is entertained that this policy of anticipating requirements several months will not be continued, and that, therefore, a temporary relaxing of demand will be encountered in mid-winter. This, however, is a reasonable one; the expansion of demand during the past six months has been too rapid and great to continue excepting in the one production of railway material, but due credit must be given to this very strong factor. Already rails enough have been sold to be made next year to lay between six and seven thousand miles of road. So far this year our railway construction foots up 6,000 miles as against only 2,325 miles at the same time last year. The railroad builders are making no mistake. The published gross earnings for October of 89 roads as compared with October last year shows an increase of nearly $2,000,000, and for ten months the increase is over $20,000,000 as against last year on 82 roads. The present strong features of the markets are, in a nut-shell, this: that material is in moderate supply, that prices are hardening, and that no probable causes are at work to interfere with the upward tendencies in every field of enterprise.